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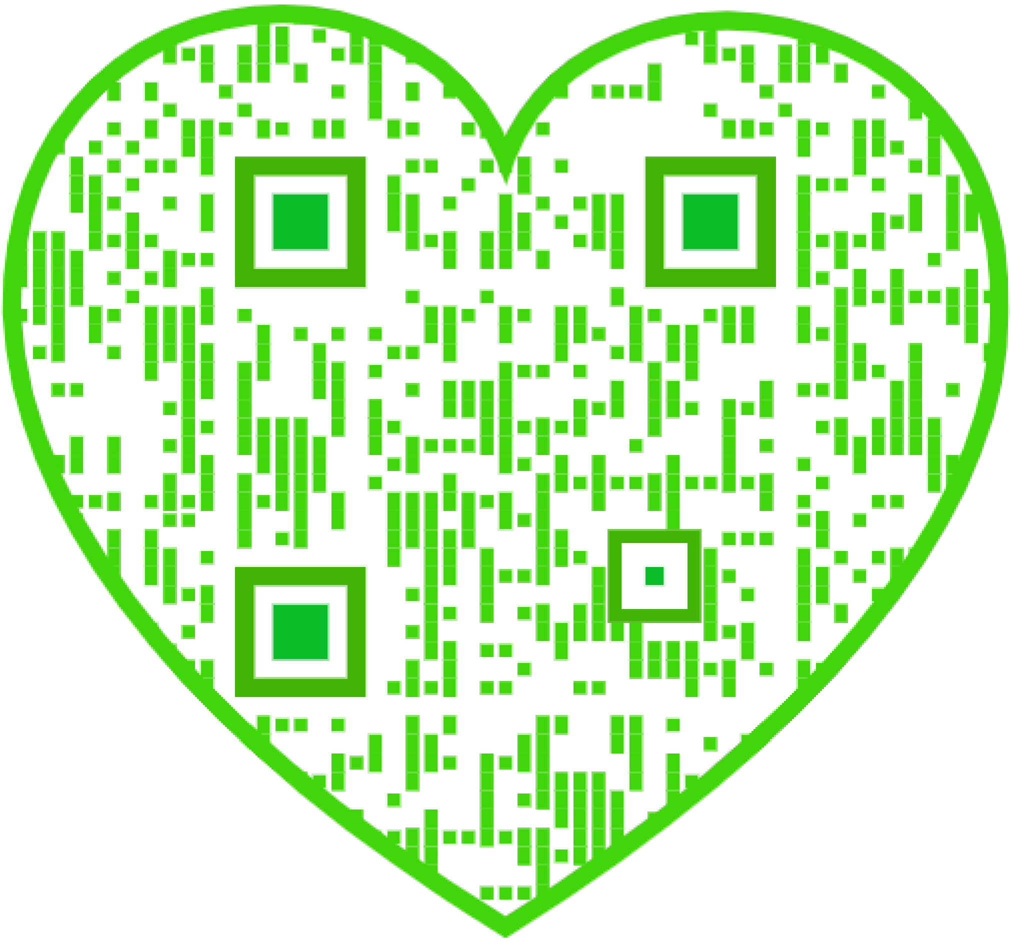

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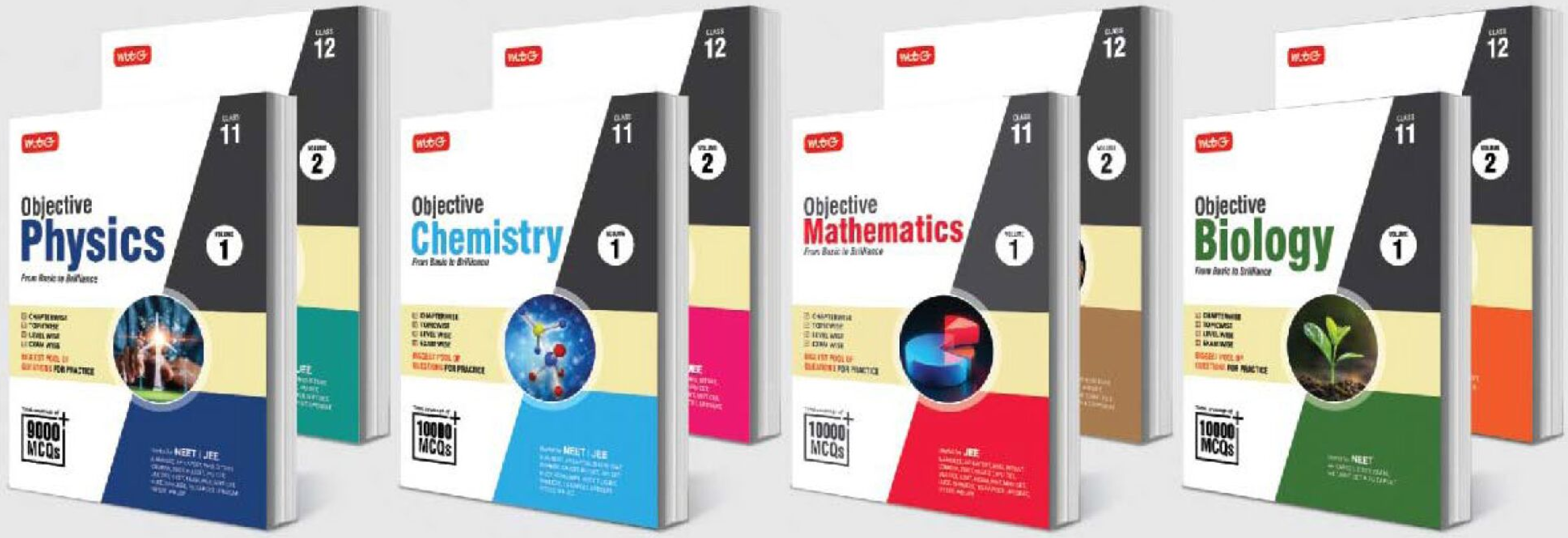
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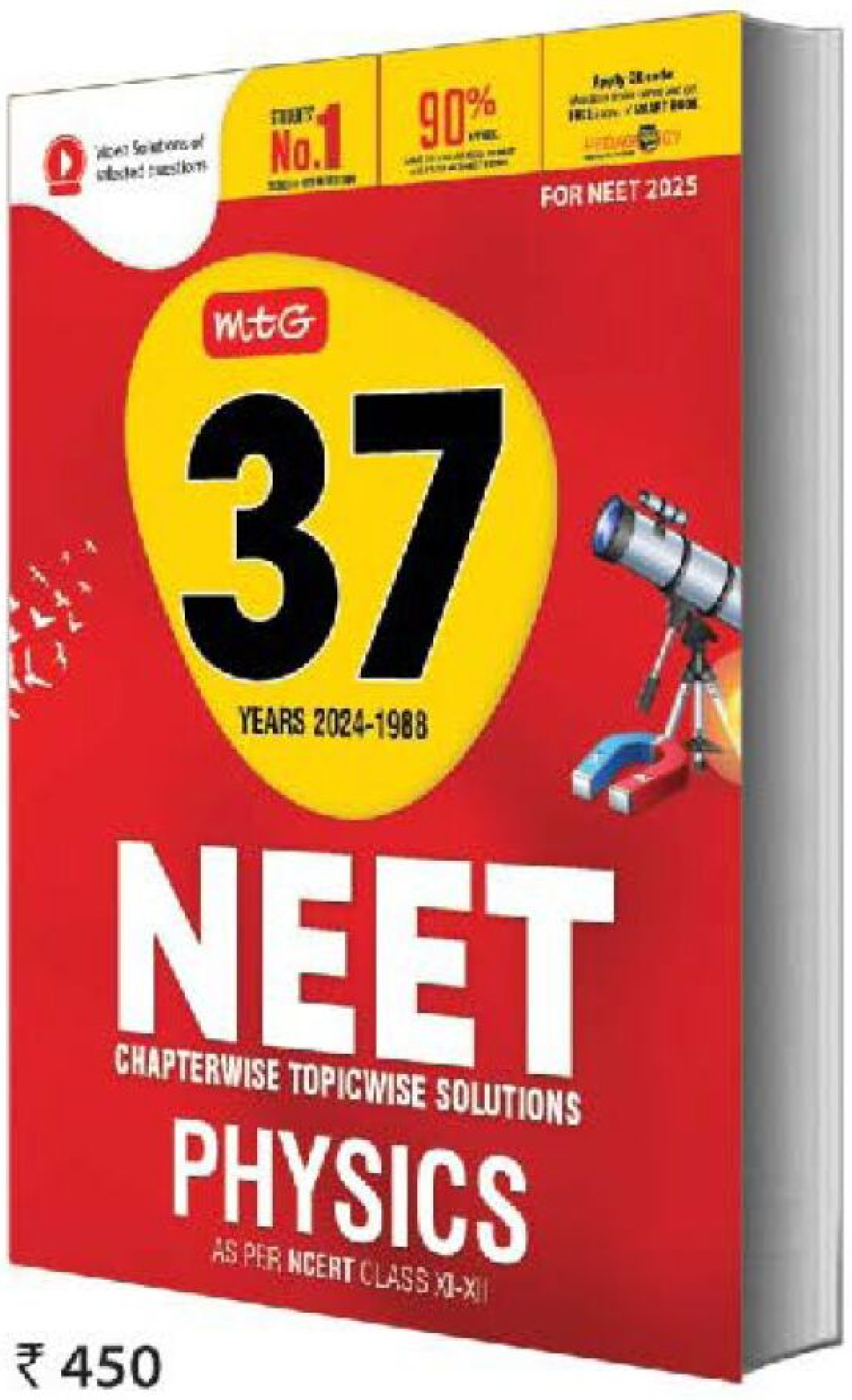
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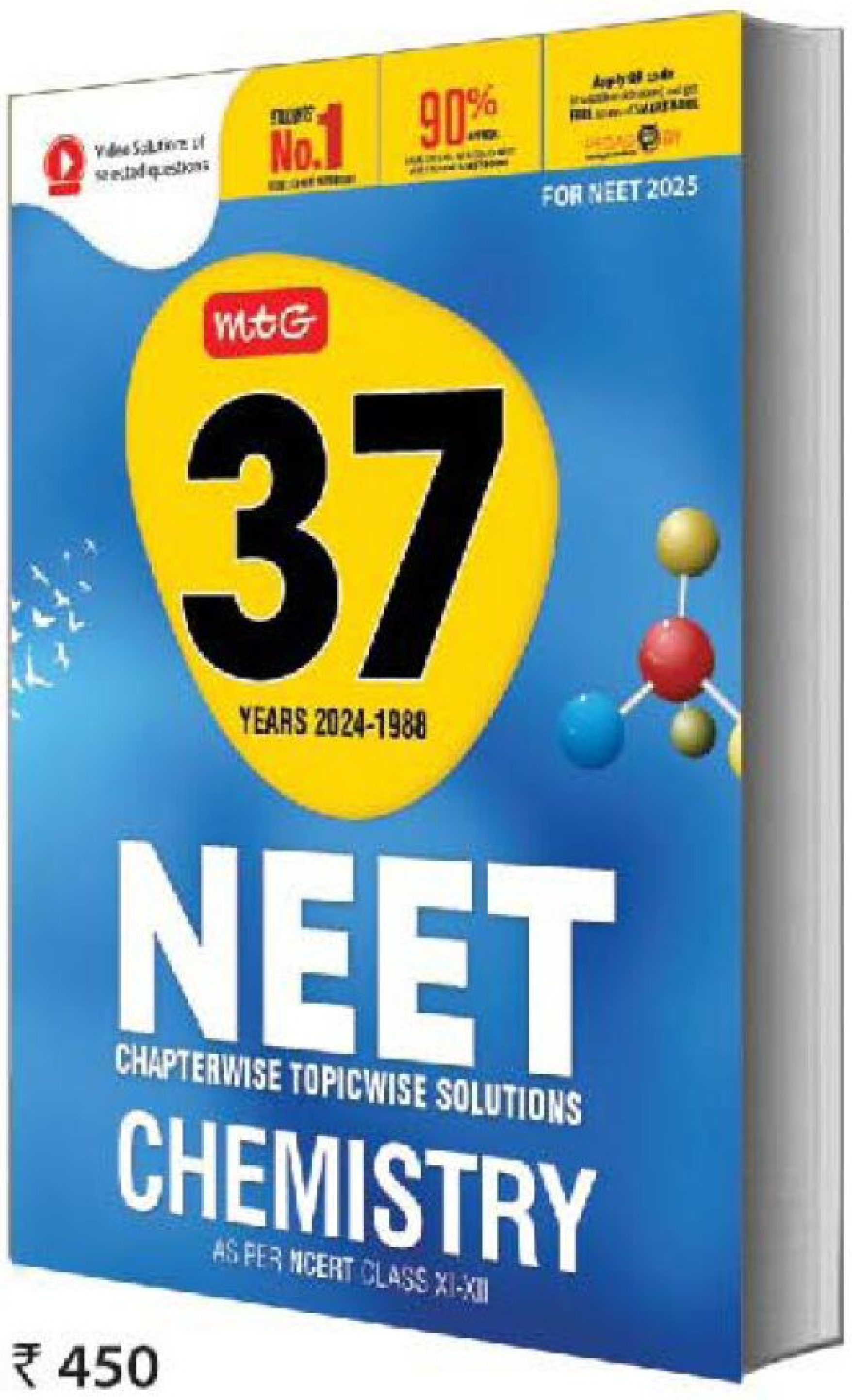
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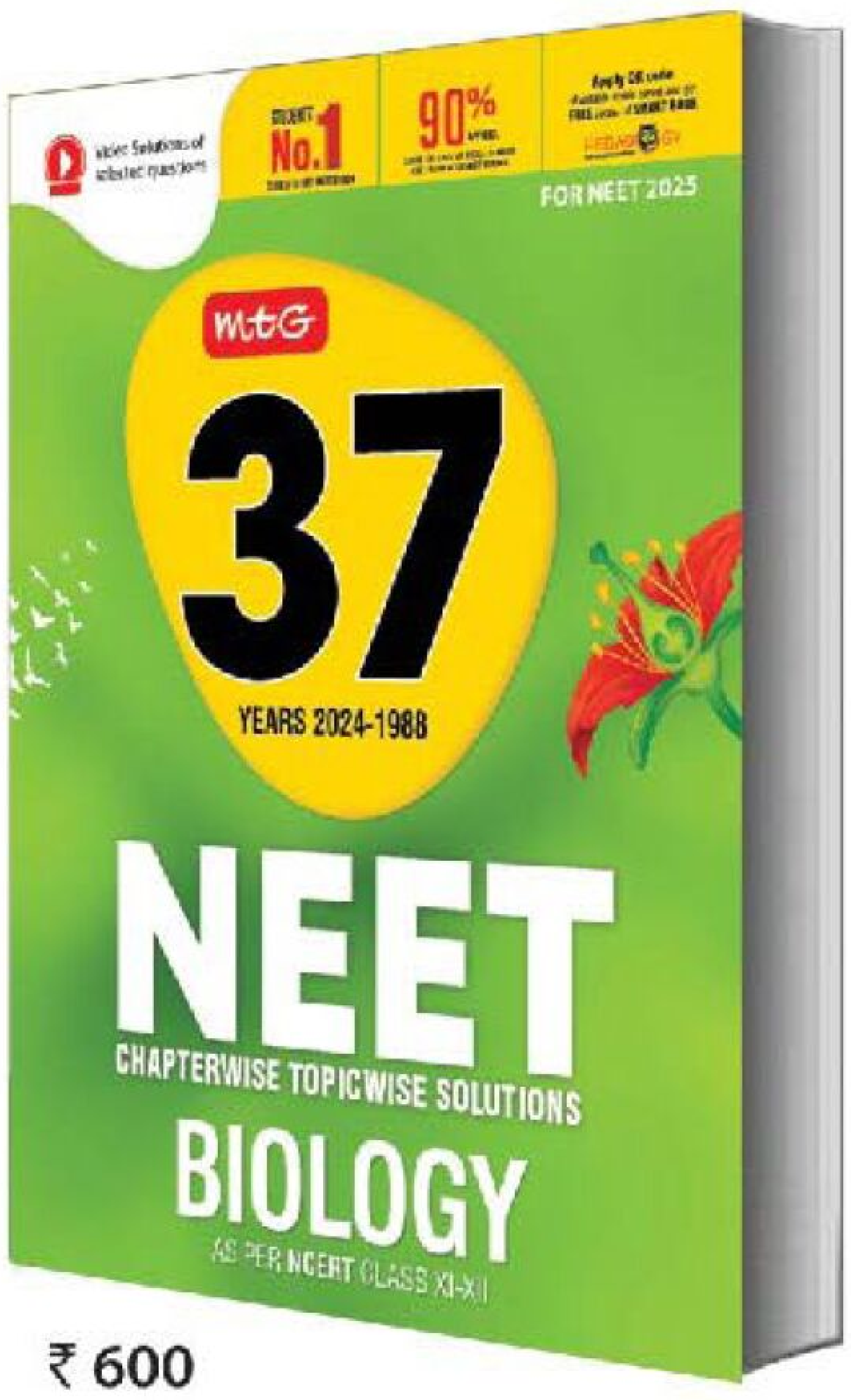
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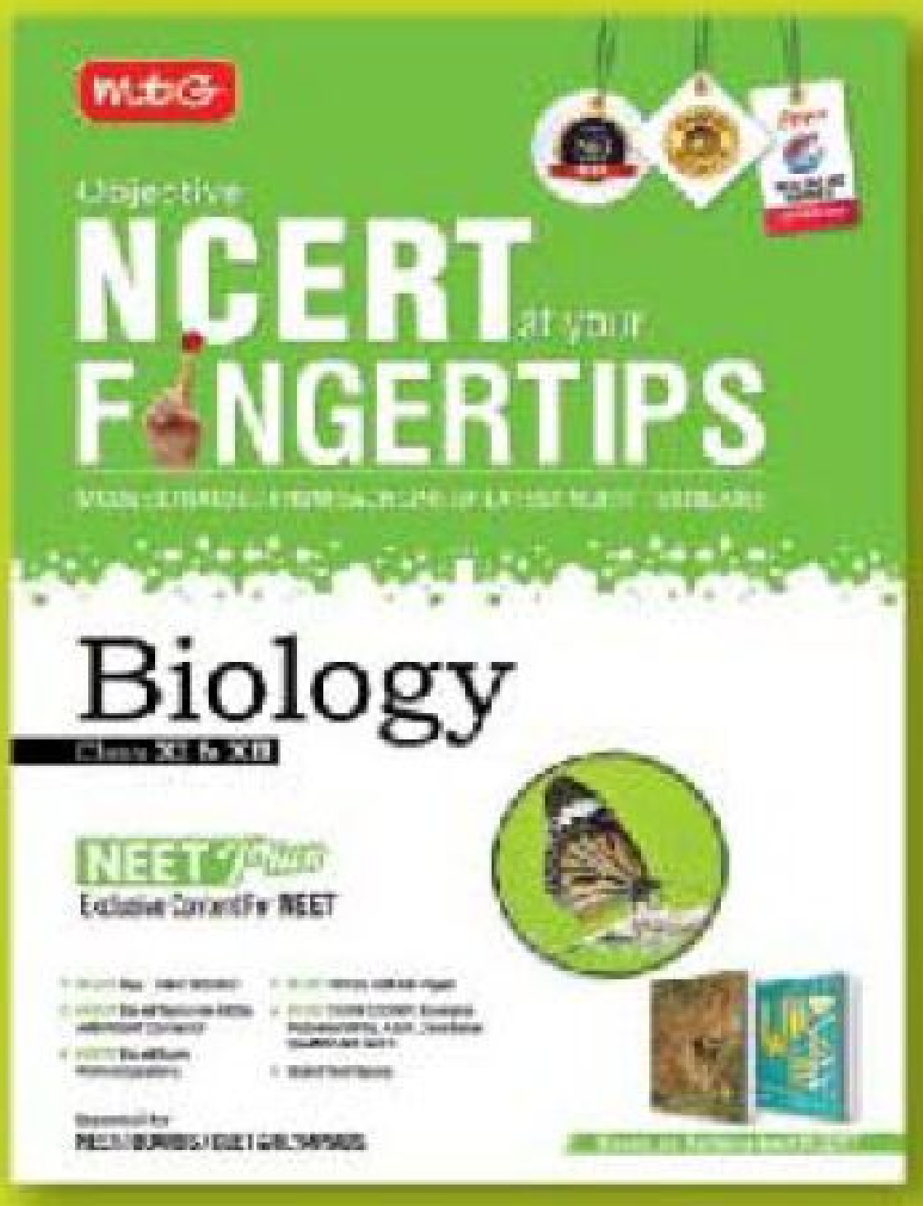
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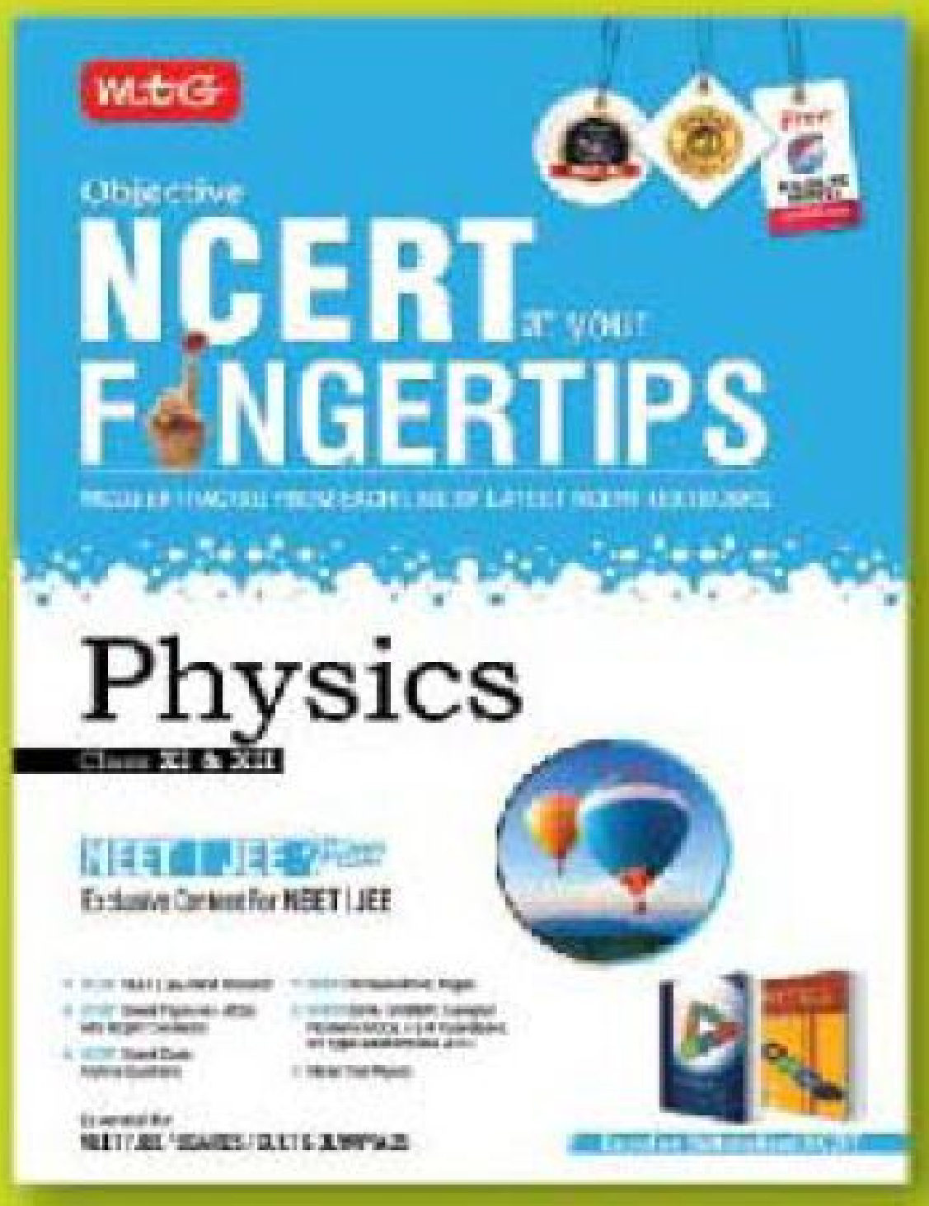
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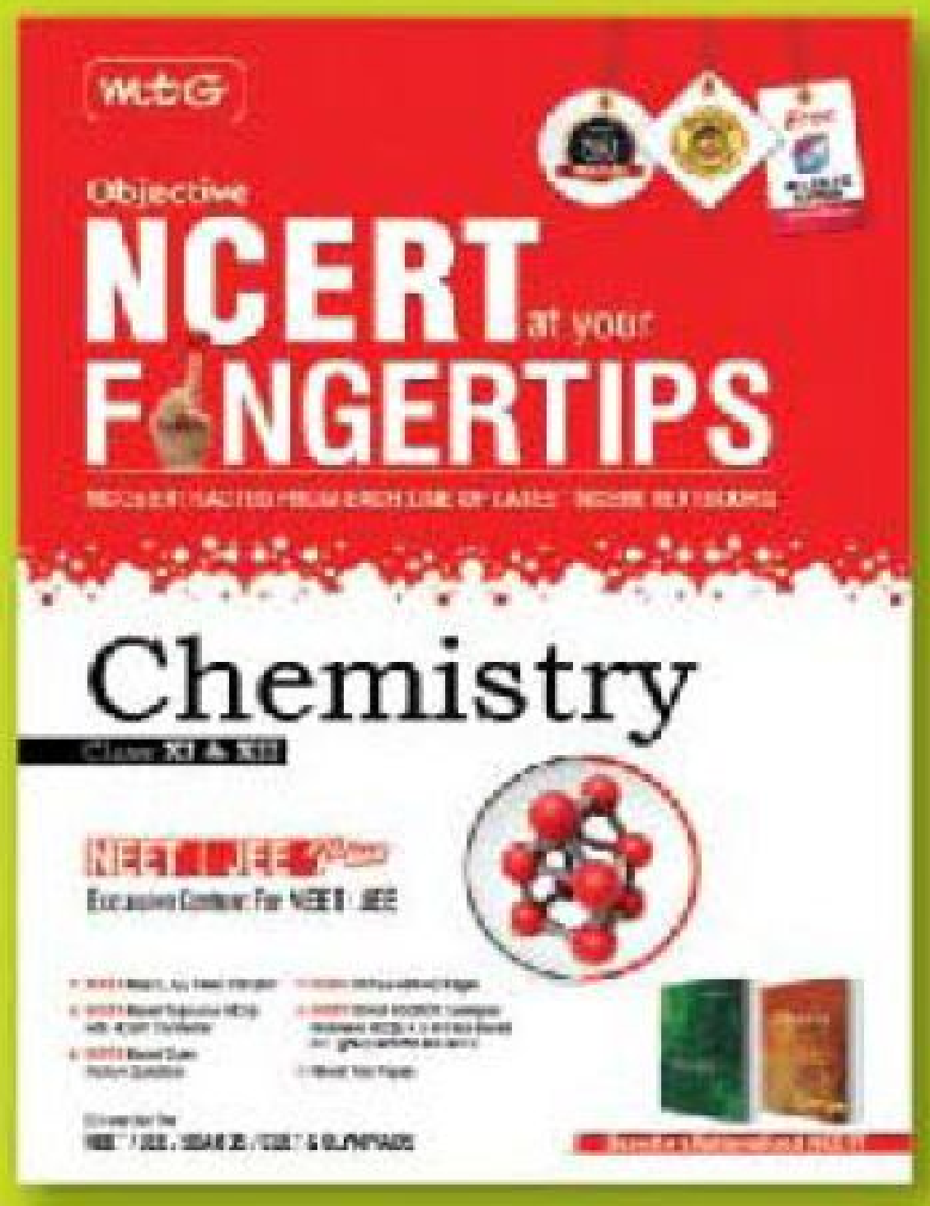
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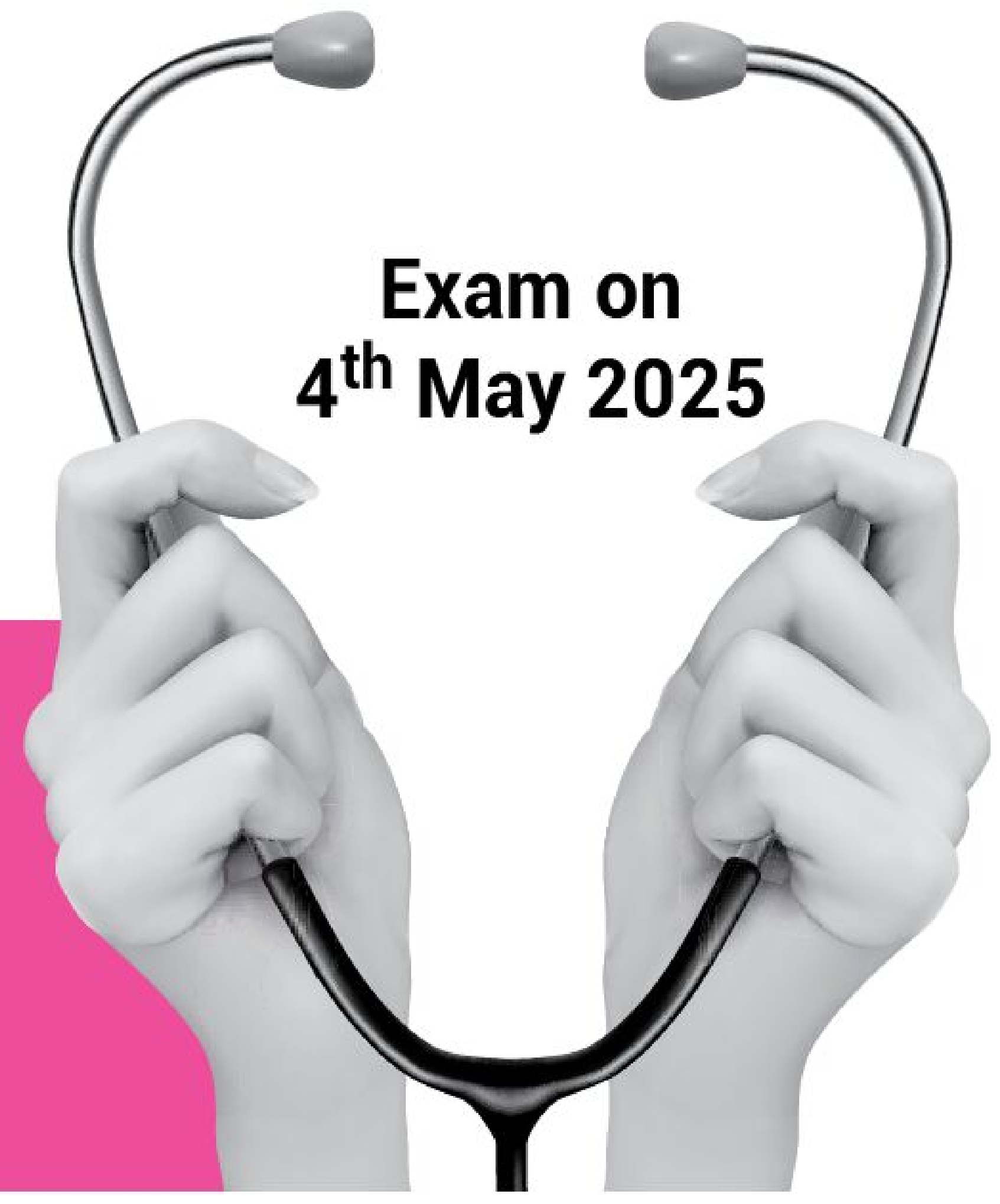
NEET 2025



Exam on
4th May 2025

BOTANY

1. Ecological diversity is
   (a) species diversity
   (b) genetic diversity
   (c) ecosystem diversity
   (d) all of these.

2. What does the filiform apparatus do at the entrance into ovule?
   (a) It brings about opening of the pollen tube.
   (b) it guides pollen tube from antipodal to egg.
   (c) It helps in the entry of pollen tube into a synergid.
   (d) It prevents entry of more than one pollen tube into the embryo sac.

3. A bacteriophage DNA has the ability to
   (a) replicate when attached with bacterial chromosome
   (b) replicate freely but under control of bacterial chromosome
   (c) replicate within bacterial cell independent of control of bacterial chromosome DNA
   (d) replicate only when bacterial cell divide by binary fission.

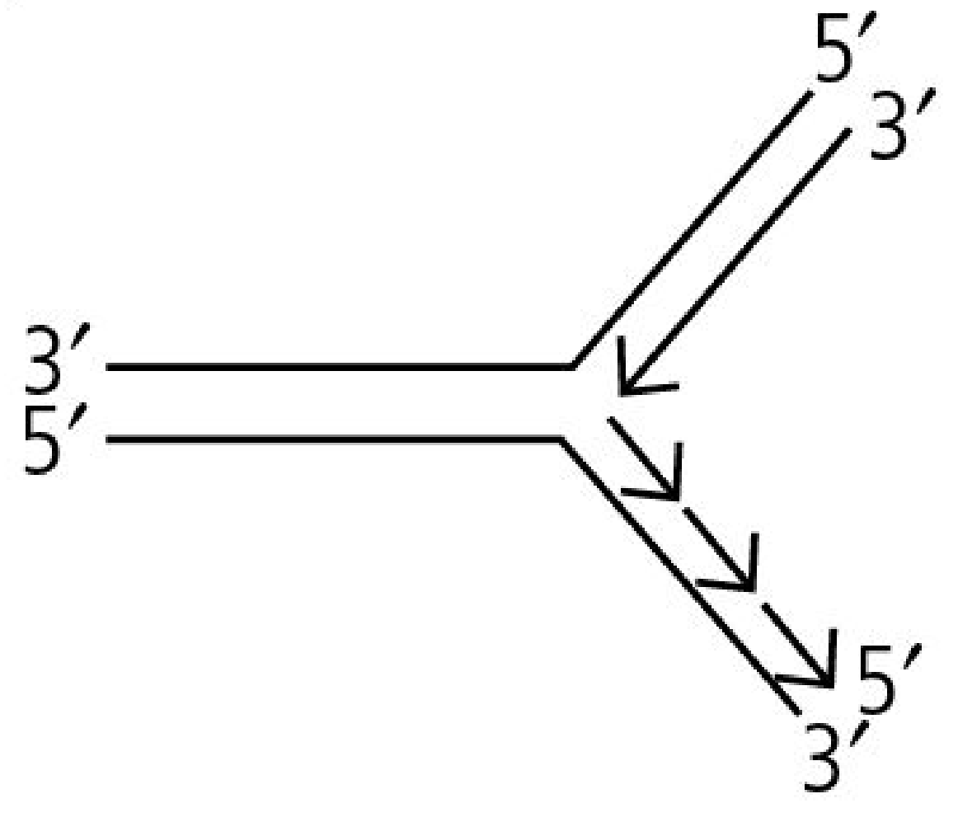
4. Why population fluctuates when it reaches the carrying capacity?
   (a) Due to limited resources
   (b) Due to exponential growth
   (c) Due to unlimited natural resources
   (d) Due to increased reproductive rate

5. Which one of the following cannot be explained on the basis of Mendel's law of dominance?
   (a) The discrete unit controlling a particular character is called a factor.
   (b) Out of one pair of factors one is dominant, and the other recessive.
   (c) Alleles do not show any blending and both the characters recover as such in F_2 generation.
   (d) Factors occur in pairs.

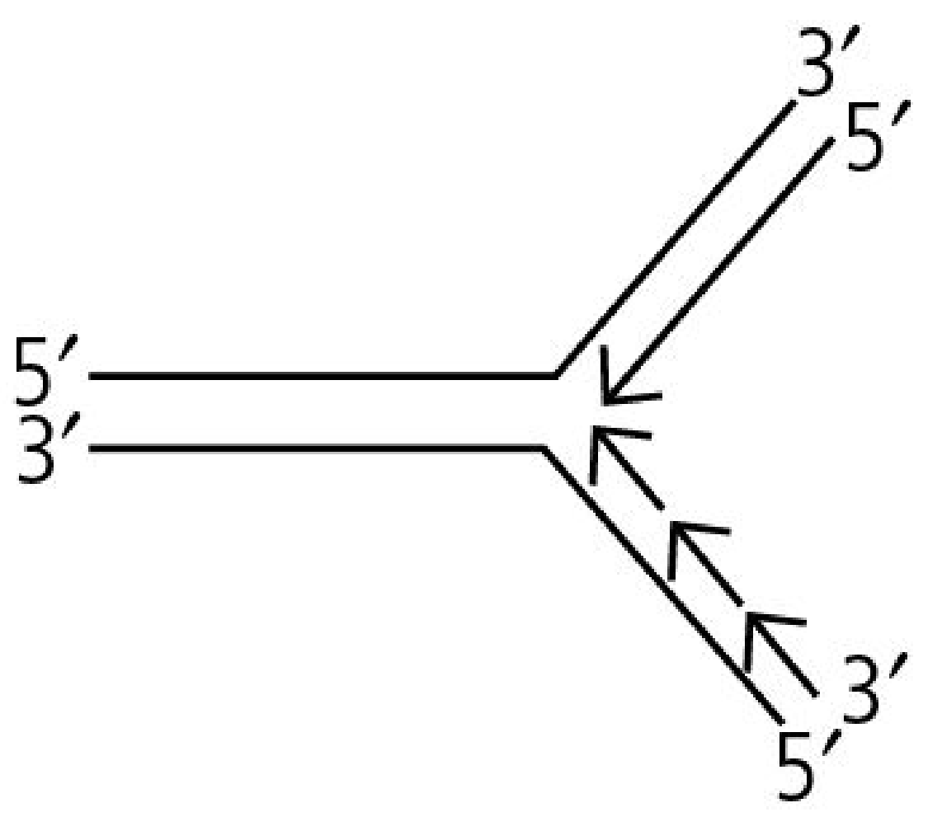
6. Choose the correct option for the above statements.
   I. Purified DNA can be precipitated by adding chilled ethanol in the solution.
   II. Cellulase is used to break down the cell to release plant DNA.
   (a) I is true but II is false.
   (b) I is false but II is true.
   (c) Both I and II are true.
   (d) Both I and II are false.

7. Which one of the following correctly represents the manner of replication of DNA?

(a)



(b)



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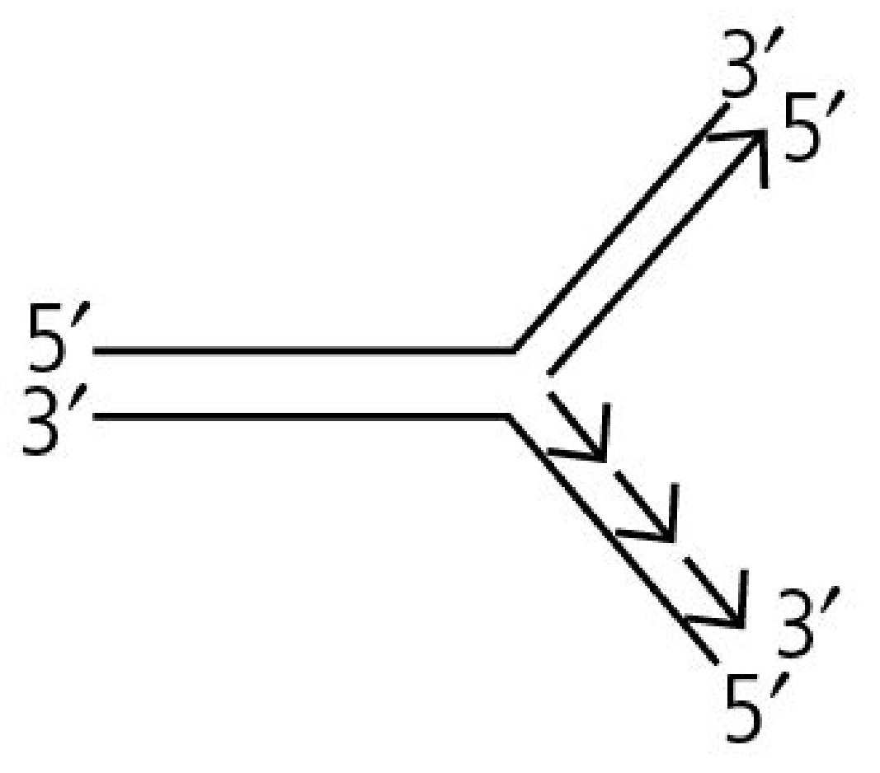

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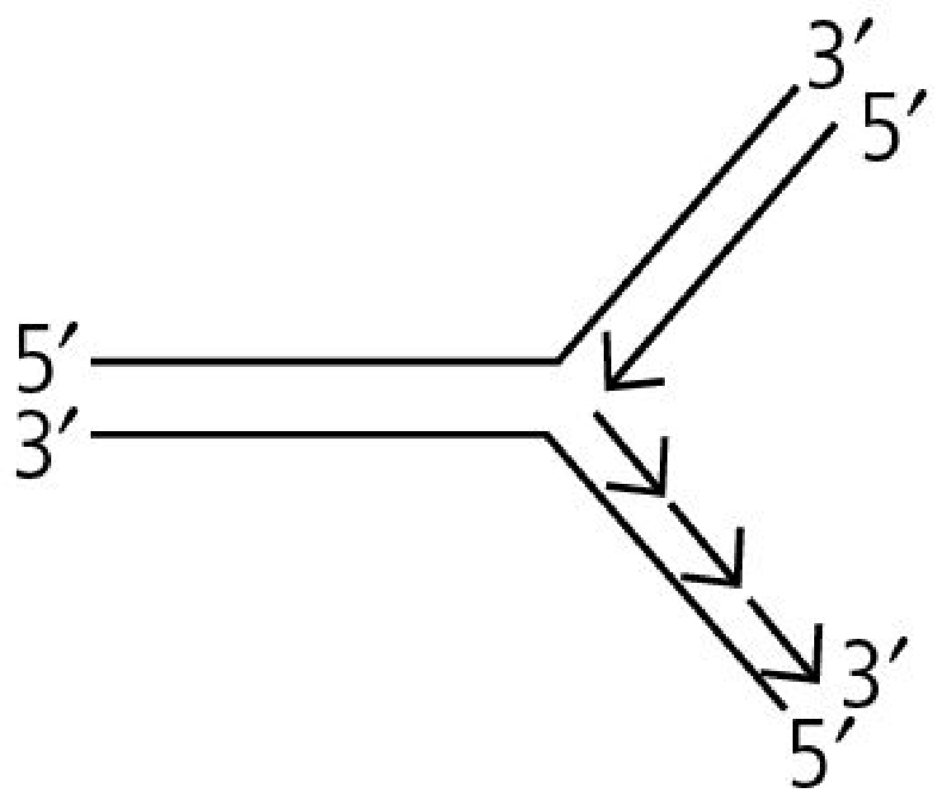

8. 'Flocs' refer to
   (a) masses of bacteria associated with fungal filaments to form a mesh-like structure
   (b) primary sludge formed in the sewage treatment plant
   (c) the remaining part of the sludge
   (d) 'biogas' formed from the fermentation of organic wastes.

9. Match List I with List II.

	List I		List II
A.	Citric acid	(i)	*Trichoderma*
B.	Cyclosporin A	(ii)	*Clostridium*
C.	Statins	(iii)	*Aspergillus*
D.	Butyric acid	(iv)	*Monascus*

Choose the correct answer from the options given below.
   (a) A-(iii), B-(i), C-(ii), D-(iv)
   (b) A-(iii), B-(i), C-(iv), D-(ii)
   (c) A-(i), B-(iv), C-(ii), D-(iii)
   (d) A-(iii), B-(iv), C-(i), D-(ii)

10. Select the mismatched pair.
   (a) Explant – Tissue culture
   (b) Totipotency – Capacity to generate
   (c) Stem – Free from virus
   (d) Protoplast – Somatic hybrid

11. Consider the following statements.

I. Yeast used in making bread and beverages is a prokaryotic fungus.
II. Streptokinase is produced by *Streptococcus* and modified by genetic engineering is used as a clot buster.
III. Lipases are added in detergent for removing oily stains from laundry.
IV. Pectinases are used in clearing fruit juices.

Which of the statements given above are correct?

(a) I, II, III and IV
(b) I, II and III
(c) II, III and IV
(d) III and IV

12. In gel electrophoresis, where is the gel sample loaded?

(a) In the wells
(b) Towards positive electrode
(c) Towards negative electrode
(d) Both (a) and (c)

13. What is the correct sequence of the formation of female gametophyte in angiosperms?

(a) Nucellus, megaspore tetrad, megaspore mother cell, megaspore, female gametophyte
(b) Megaspore tetrad, nucellus, megaspore mother cell, megaspore, female gametophyte
(c) Nucellus, megaspore mother cell, megaspore tetrad, megaspore, female gametophyte
(d) Megaspore mother cell, megaspore tetrad, megaspore, nucellus, female gametophyte

14. Match List I with List II.

	List I		**List II**
A.	Pod shape	1.	Wrinkled
B.	Pod color	2.	Yellow
C.	Seed shape	3.	Constricted
D.	Seed colour	4.	Green
		5.	Grey

Choose the correct answer from the options given below.

(a) A-4, B-5, C-2, D-1
(b) A-3, B-2, C-1, D-4
(c) A-2, B-3, C-1, D-4
(d) A-1, B-2, C-4, D-3

15. *Bacillus thuringiensis* forms protein crystals which contain insecticidal protein. This protein

(a) binds with epithelial cells of midgut of the insect pest ultimately killing it
(b) is coded by several genes including the gene *cry*
(c) is activated by acidic pH of the foregut of the insect pest
(d) does not kill the carrier bacterium which is itself resistant to this toxin.

16. Independent assortment of genes does not take place when

(a) genes are located on homologous chromosomes
(b) genes are linked and located on same chromosomes
(c) genes are located on non-homologous chromosomes
(d) all of these.

17. Choose the incorrect statement.

(a) In nature, predators are imprudent.
(b) Some species of insects and frogs are cryptically coloured to avoid predators.
(c) For plants, herbivores are the predators.
(d) *Calotropis* produces highly poisonous cardiac glycoside to protect itself from herbivores.

18. Which of the following are used in gel electrophoresis?

I. Ethidium bromide
II. Restriction endonuclease
III. Agarose
IV. UV radiation

Choose the correct option.

(a) I and II only
(b) I and III only
(c) I, II and IV only
(d) I, II, III and IV

19. Given below are two statements.

Statement I : Specific texture and flavour of cheese is due to type of microbe used.

Statement II : Cheese is always fermented by bacteria.

In the light of the above statements choose the correct answer from the options given below.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

20. Extinction of a particular species leads to extinction of the animal species associated with it. Which evil quartet is responsible for this?

(a) Habitat loss
(b) Co-extinction
(c) Alien-species invasion
(d) Over-exploitation

21. Logistic growth occurs when there is

(a) no resistance from increasing population
(b) unlimited food
(c) limited resources
(d) all of these.

22. Match List I with List II.

	List I		List II
A.	Parthenocarpy	(i)	Seed formation without fertilisation
B.	Polyembryony	(ii)	More than one embryo in same seed
C.	Apomixis	(iii)	Seedless fruits without fertilsation
		(iv)	Embryo develops from a somatic cell

Choose the correct answer from the options given below.

(a) A-(iv), B-(ii), C-(iii) (b) A-(iii), B-(ii),C-(i)

(c) A-(i), B-(iv), C-(iii) (d) A-(ii), B-(iii), C-(i)

23. Given below are two statements.

Statement I : Biodiversity is essential for stability of an ecosystem.

Statement II : Communities with more species tend to be more stable than those with less species.

In the light of the above statements choose the correct answer from the options given below.

(a) Both statements I and II are correct.

(b) Statement I is correct but statement II is incorrect.

(c) Statement I is incorrect but statement II is correct.

(d) Both statements I and II are incorrect.

24. Industrial production of ethanol from starch is brought about by

(a) *Saccharomyces* (b) *Streptococcus*

(c) *Rhizopus* (d) *Lactobacillus.*

25. Read the given statements and select the correct option.

(i) AUG is recognised by initiator *t*RNA.

(ii) UAA, UAG and UGA is recognised by terminator *t*RNA.

(iii) There is no *t*RNA is for stop codon.

(iv) *t*RNAs are specific for each amino acid.

(a) (i), (iii) and (iv) are correct.

(b) (ii) and (iv) are correct.

(c) (i) and (iv) are correct.

(d) (ii) and (iii) are correct.

26. EMP can produce a total of

(a) 6 ATP (b) 8 ATP (c) 24 ATP (d) 38 ATP.

27. Which of the following has correct specific epithet?

(a) *indica* (b) *Panthera*

(c) *canis* (d) *Solanum*

28. Bisexual is a condition in which flower bears

(a) either androecium or gynoecium

(b) staminode and androecium

(c) both androecium and gynoecium

(d) staminode and gynoecium.

29. Match List I with List II.

	List I		List II
A.	G_0	(1)	Mitosis
B.	Equational division	(2)	Telophase
C.	Reformation of Golgi complex	(3)	Quiescent stage
D.	Condensation of chromosomal material	(4)	Prophase

Choose the correct answer from the options given below.

	A	B	C	D
(a)	4	1	2	3
(b)	3	1	4	2
(c)	3	2	4	1
(d)	3	1	2	4

30. Family Solanaceae is placed in the same order with Family _______.

(a) Anacardiaceae (b) Convolvulaceae

(c) Poaceae (d) Liliaceae

31. Match List I with List II.

	List I		List II
A.	Smallest cell	(i)	Nucleus
B.	Chromosome	(ii)	Centriole
C.	Semi-fluid matrix	(iii)	Egg of an ostrich
D.	Membraneless organelle	(iv)	Mycoplasma
E.	Largest cell	(v)	Cytoplasm

Choose the correct answer from the options given below.

(a) A-(iv), B-(i), C-(v), D-(ii), E-(iii)

(b) A-(i), B-(v), C-(iii), D-(ii), E-(iv)

(c) A-(iii), B-(ii), C-(iv), D-(v), E-(i)

(d) A-(iv), B-(ii) C-(v), D-(i), E-(iii)

32. Given below are two statements.

Statement I : Proteins are catalysts which fasten the rate of a given metabolic reaction.

Statement II : Proteins with catalytic power are called enzymes.

In the light of the above statements choose the correct answer from the options given below.

(a) Both statements I and II are true.

(b) Both statements I and II are false.

(c) Statement I is true but statement II is false.

(d) Statement I is false but statement II is true.

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1.	(a)	**2.**	(c)	**3.**	(b)	**4.**	(a)	**5.**	(c)
6.	(c)	**7.**	(a)	**8.**	(b)	**9.**	(c)	**10.**	(c)
11.	(b)	**12.**	(c)	**13.**	(c)	**14.**	(b)	**15.**	(b)
16.	(d)	**17.**	(c)	**18.**	(b)	**19.**	(c)	**20.**	(d)
21.	(a)	**22.**	(c)	**23.**	(b)	**24.**	(c)	**25.**	(c)
26.	(a)	**27.**	(b)	**28.**	(c)	**29.**	(c)	**30.**	(d)
31.	(b)	**32.**	(b)	**33.**	(c)	**34.**	(a)	**35.**	(a)
36.	(c)	**37.**	(b)	**38.**	(c)	**39.**	(b)	**40.**	(c)

33. Which of the following organisms possesses characteristics of both a plant and an animal?

(a) *Euglena* (b) *Paramecium*
(c) Bacteria (d) Mycoplasma

34. The enzymes of EMP are located in

(a) cytoplasm (b) mitochondria
(c) lysosomes (d) ribosomes.

35. Mesophyll of monocotyledon leaf are not differentiated into

(a) palisade parenchyma (b) spongy parenchyma
(c) bulliform cells (d) both (a) and (b).

36. **Assertion :** All eukaryotic photosynthetic organisms contain chlorophyll *a*.

Reason : Chlorophyll *b* is the chief pigment associated with photosynthesis.

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is not correct.
(d) Assertion is not correct but reason is correct.

37. Branched stems are found in

(a) *Cycas* (b) *Pinus*
(c) *Sphagnum* (d) *Gelidium.*

38. Given below are two statements.

Statement I : Gibberellins are less effective than auxins in parthenocarpic fruit formation.

Statement II : GA_3 is used to speed up the malting process.

In the light of the above statements choose the correct answer from the options given below.

(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

39. Match List I with List II.

	List I		**List II**
A.	Virus	(i)	Leaf rolling and curling
B.	Prions	(ii)	Dwarfing and stunting in plants
C.	Viroids	(iii)	Potato spindle tuber disease
		(iv)	Mad cow disease
		(v)	Cr-Jacob Disease (CJD)
		(vi)	Bovine Spongiform
			Encephalopathy (BSE)

Choose the correct answer from the options given below.

(a) A – (i) and (iv), B – (v) and (vi), C – (ii) and (iii)
(b) A – (i) and (v), B – (ii) and (iii), C – (iv) and (vi)
(c) A – (i) and (iii), B – (ii), C – (iv), (v) and (vi)
(d) A – (i) and (ii), B – (iv), (v) and (vi), C – (iii)

40. Plasmodesmata are

(a) lignified cementing between cells
(b) locomotory structures
(c) nuclear pores connecting the nucleus with plasmalemma
(d) connections between adjacent cells.

41. Which of the following class of fungi is being described by the given statements?

(i) They are found in aquatic habitats and on decaying wood in moist and damp places.
(ii) Mycelium is aseptate and coenocytic.
(iii) Asexual reproduction takes place by zoospores (motile) or by aplanospores (non-motile).
(iv) Some common examples are mucor, *Rhizopus* and *Albugo*.

(a) Ascomycetes (b) Phycomycetes
(c) Basidiomycetes (d) Deuteromycetes

42. Match List I with List II.

	List I		**List II**
A.	IAA	(1)	Gas
B.	N^6-furfurylamino purine	(2)	Terpene
C.	ABA	(3)	Derivatives of carotenoids
D.	GA_3	(4)	Adenine derivatives
E.	C_2H_4	(5)	Indole compound

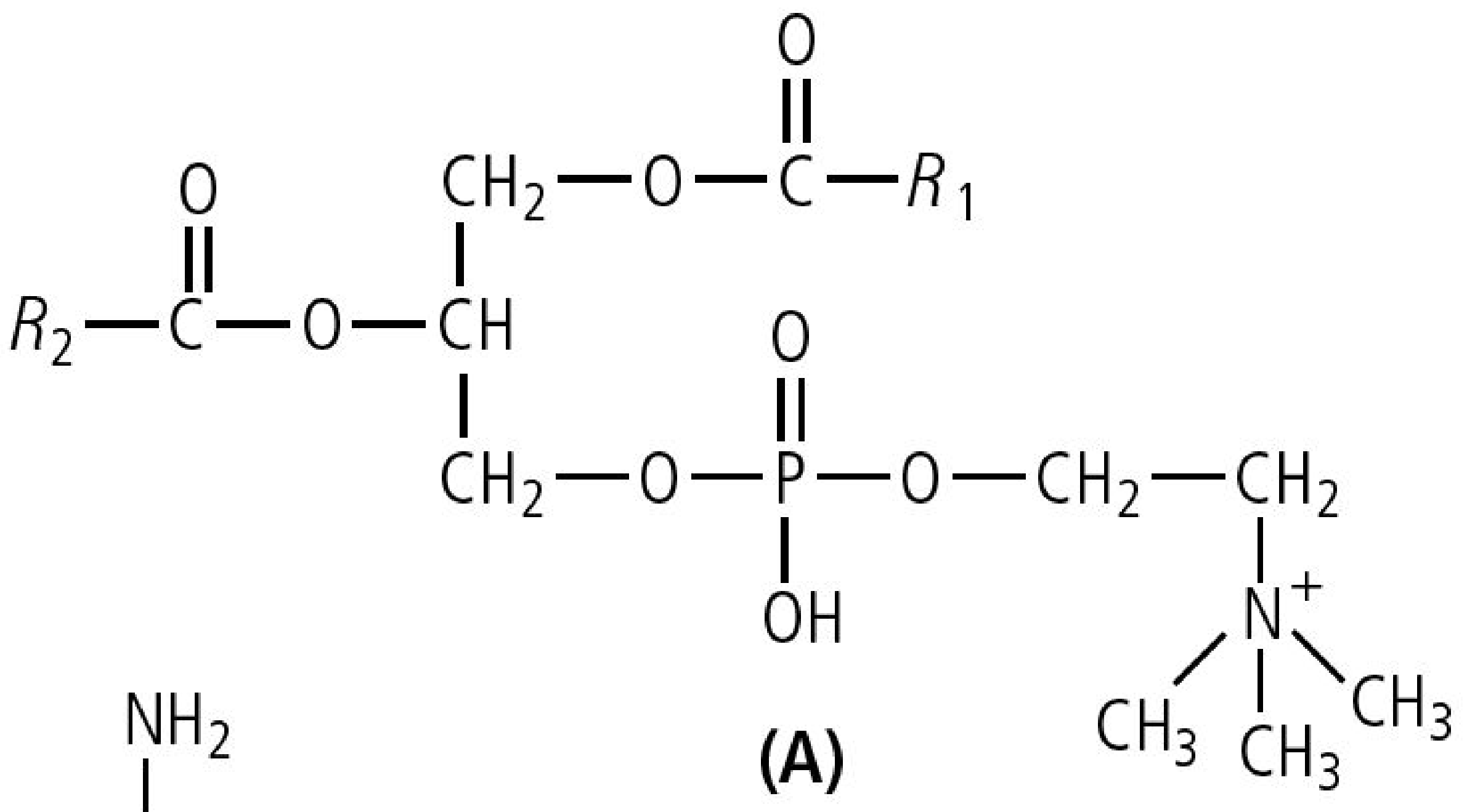
Choose the correct answer from the options given below.

	A	**B**	**C**	**D**	**E**
(a)	1	2	3	4	5
(b)	5	4	3	2	1
(c)	5	4	1	2	3
(d)	4	3	1	2	5

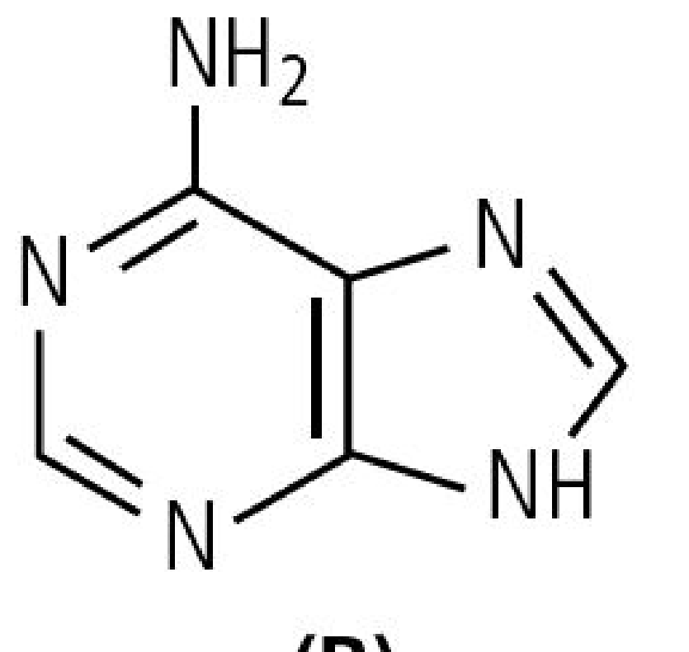
43. Bryophytes are dependent on water, because

(a) water is essential for their vegetative propagation
(b) the sperms can easily reach upto egg in the archegonium
(c) archegonium has to remain filled with water for fertilisation
(d) water is essential for fertilisation for their homosporous nature.

44. Which one of the following structural formula of two organic compounds is correctly identified along with its related function?



(A)



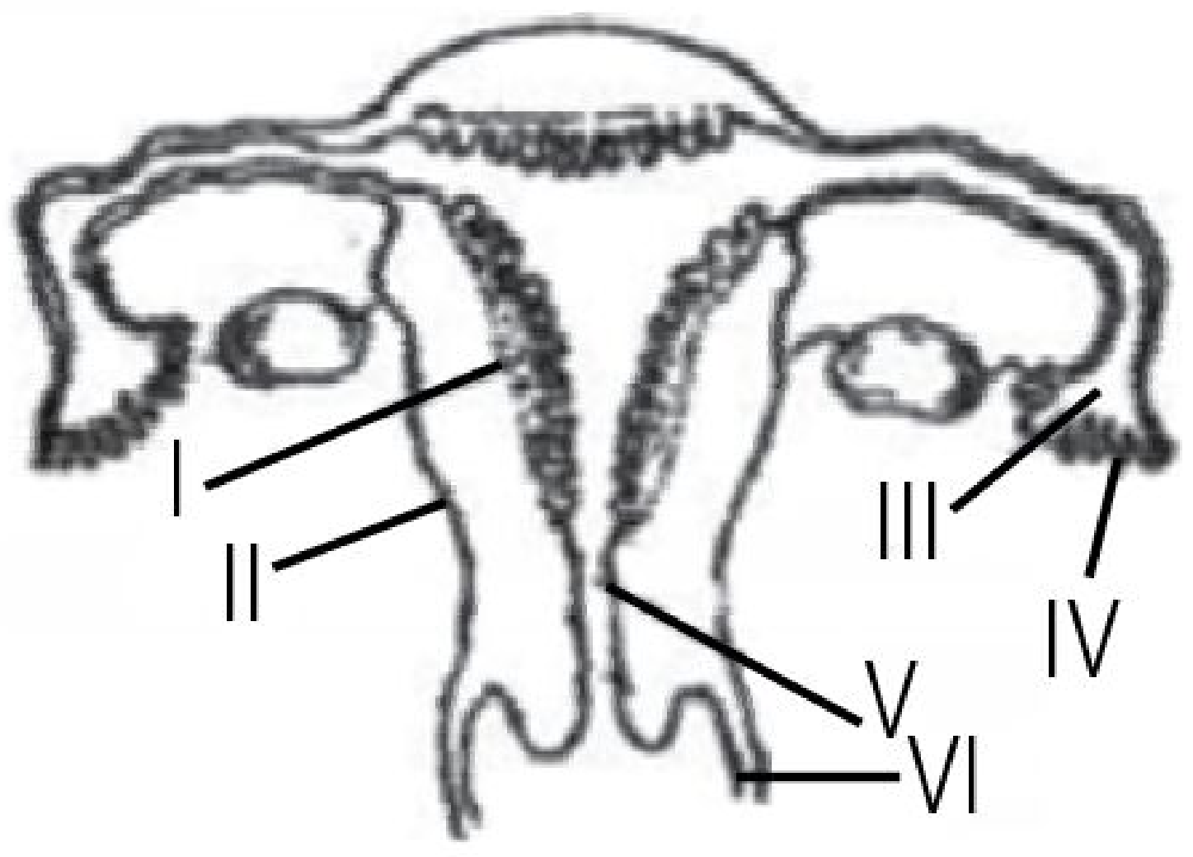
(B)

(a) A - Glyceraldehyde – Source of energy
(b) B - Uracil – A component of DNA
(c) A - Lecithin – A component of cell membrane
(d) B - Adenine – A nucleotide that makes up nucleic acids

45. What property of conifers help to reduce water loss?
(a) Thin cuticle
(b) Needle like leaves
(c) Sunken stomata
(d) Both (b) and (c)

ZOOLOGY

46. The figure given below depicts a diagrammatic sectional view of the human female reproductive system. Which set of three parts out of I-VI have been correctly identified?



(a) (II) Endometrium, (III) Infundibulum, (IV) Fimbriae
(b) (III) Infundibulum, (IV) Fimbriae, (V) Cervix
(c) (IV) Isthmus funnel, (V) Uterus, (VI) Cervix
(d) (I) Perimetrium, (II) Myometrium, (III) Fallopian tube

47. Which of the following infections can also be transmitted by sharing of injection needles, surgical instruments, etc., with infected persons, transfusion of blood from an infected mother to the fetus too?
(a) Hepatitis B and HIV
(b) Cholera and HIV
(c) Syphilis and Malaria
(d) Chlamydiasis and Mumps

48. Given below are two statements.
Statement I : The ADA gene provides instruction for producing the enzyme adenosine deaminases.
Statement II : In some children ADA deficiency can be cured by bone marrow transplantation.
In the light of the above statements choose the correct answer from the options given below.
(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

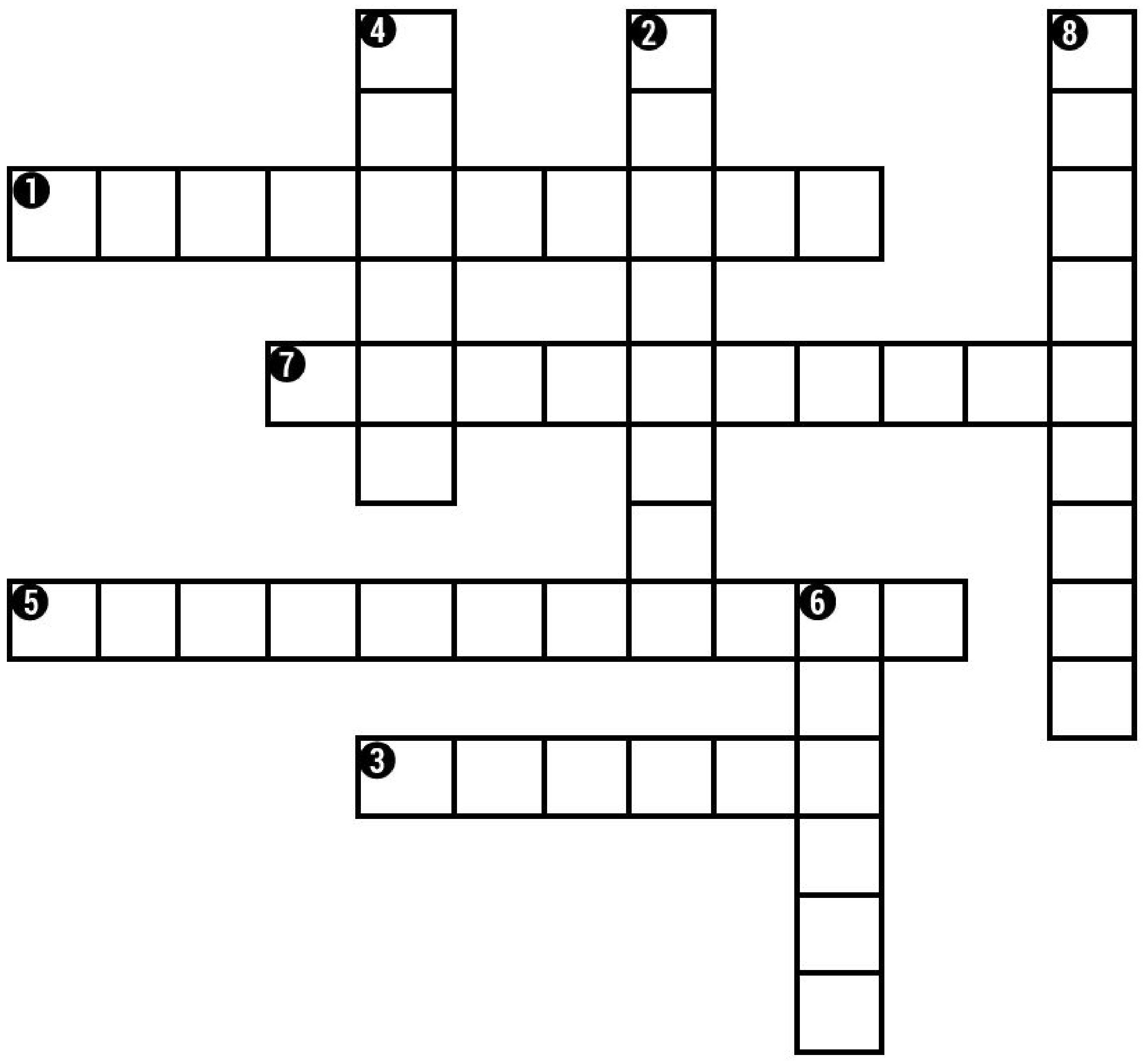
49. Identify the cranial capacity A and B of the given primates.

	Primates	Cranial capacities (in cubic centimetris)
1.	*Australopithecus*	500 cc
2.	*Homo habilis*	**A**
3.	Neanderthal man	1400 cc
4.	*Homo erectus*	**B**

Across

Fill the grid with terms related to given images.

Down



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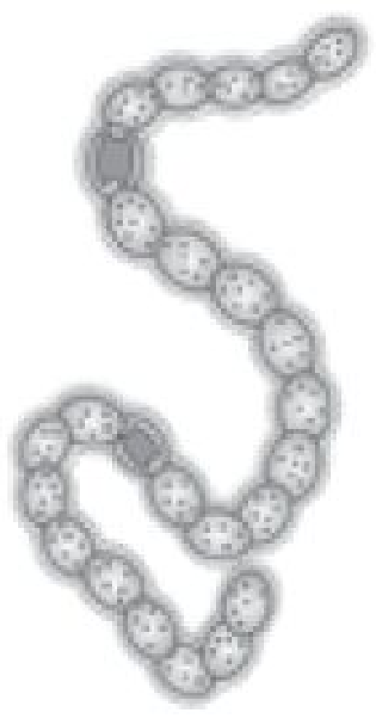

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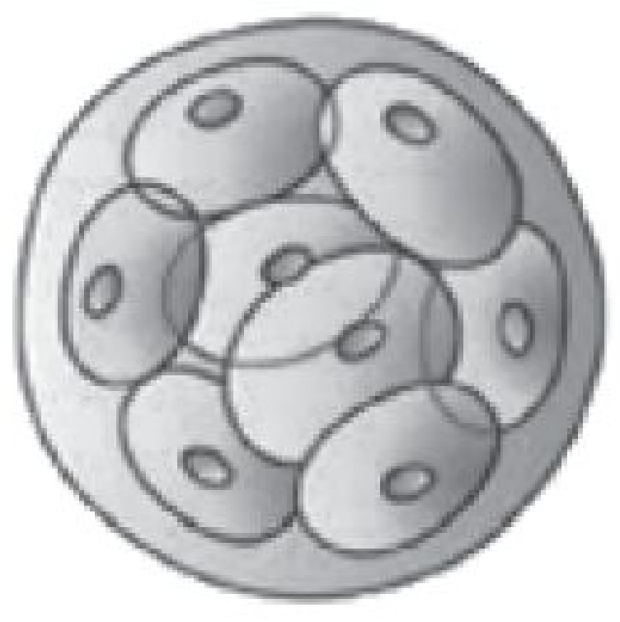

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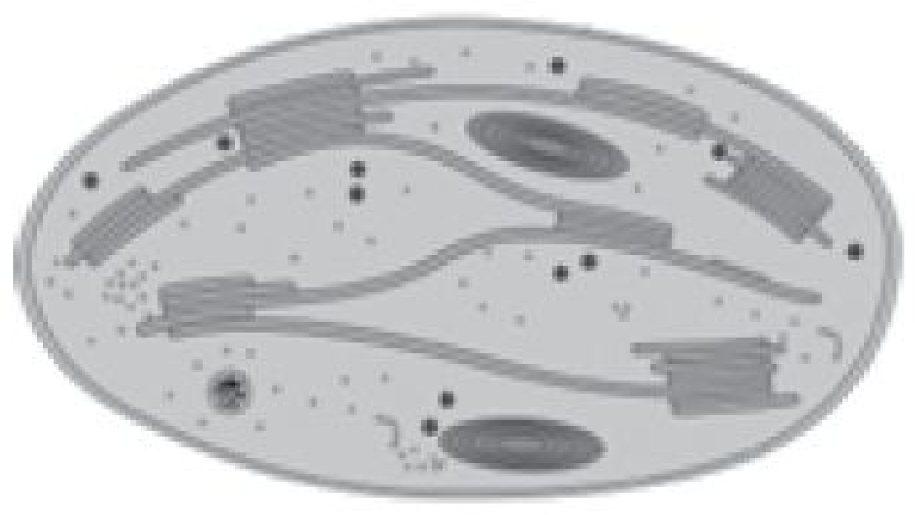

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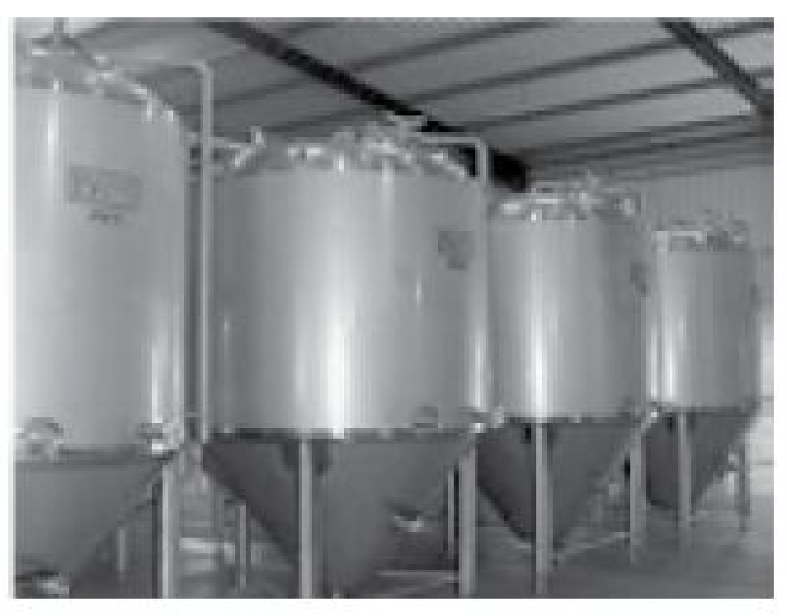

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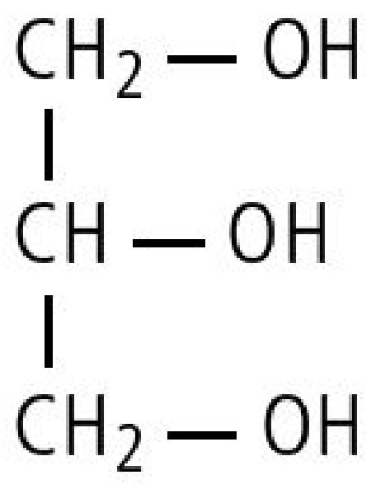
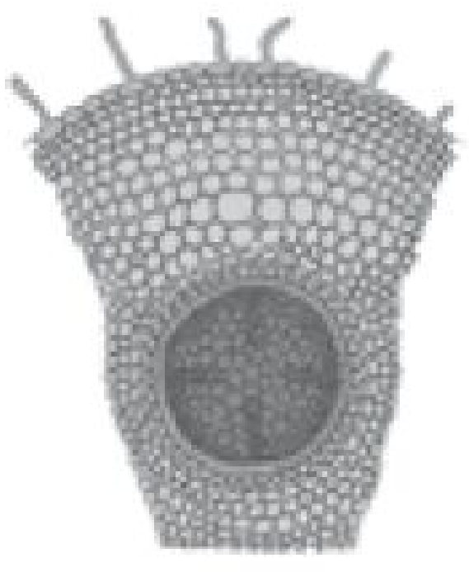


$$\begin{array}{l} CH_2-OH \\ | \\ CH-OH \\ | \\ CH_2-OH \end{array}$$

❹


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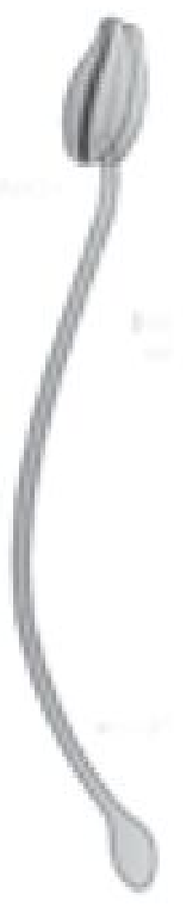

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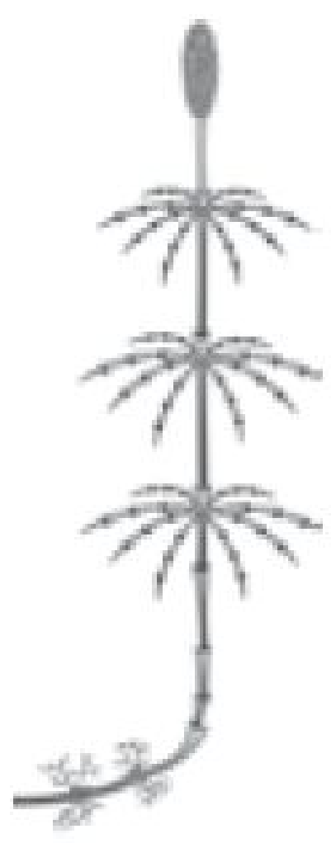


Readers can send their responses at ***editor@mtg.in*** *or post us with complete address by 10th of every month. Winners' name and answers will be published in next issue.*

Choose the correct answer from the options given below.
(a) A-900 cc, B-800 cc (b) A-700 cc, B-900 cc
(c) A-700 cc, B-1200 cc (d) A-700 cc, B-1400 cc

50. Which of the following is a correct match?
(a) Down's syndrome – 21^{st} chromosome
(b) Sickle cell anaemia – X-chromosome
(c) Haemophilia – Y-chromosome
(d) Klinefelter's syndrome – XO females

51. Given below are two statements.
Statement I : *Homo erectus* was first human like hominid.
Statement II : *Homo habilis* had brain capacity of 900 cc.
In the light of the above statements choose the correct answer from the options given below.
(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

52. Match List I with List II.

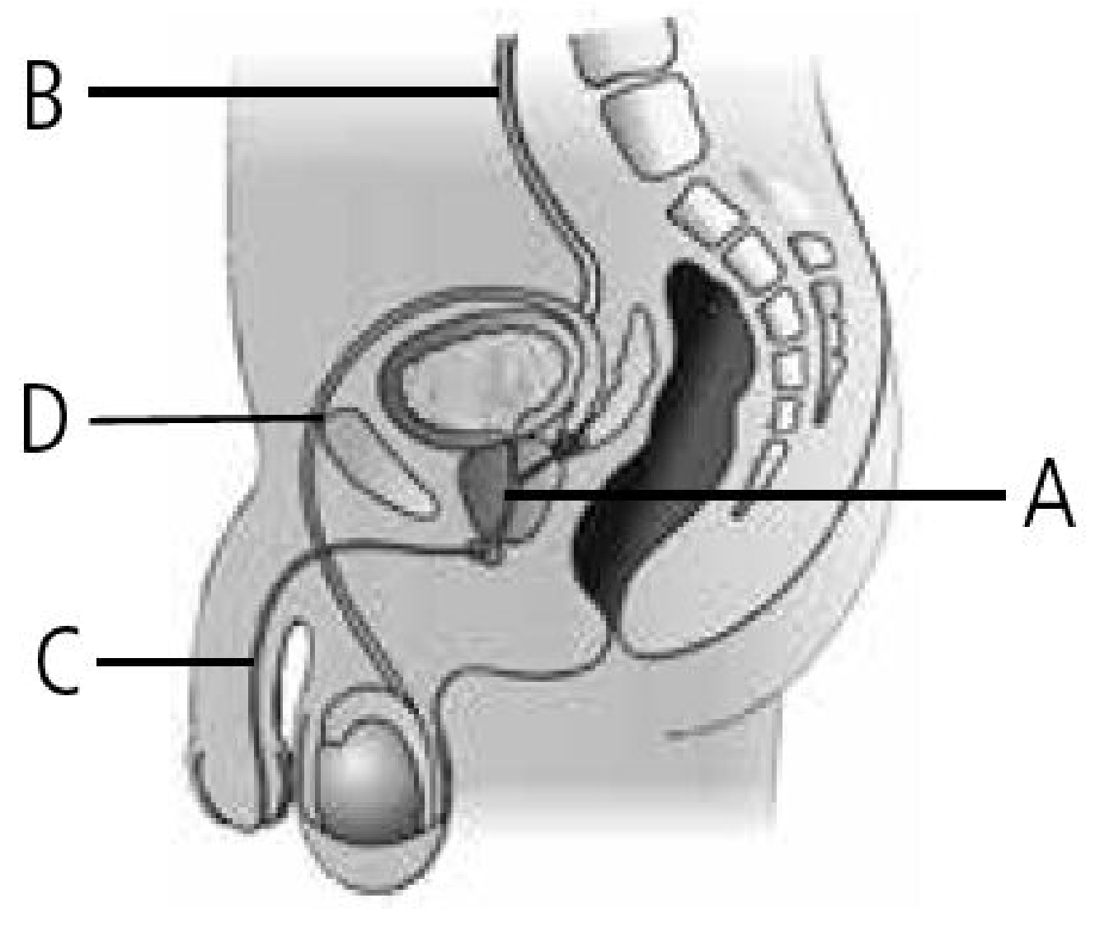
	List I		List II
A.	G.J. Mendel	1.	Chromosomal theory of inheritance
B.	T.H. Morgan	2.	Discovered linkage in *Drosophila*
C.	Sutton and Boveri	3.	Proposed laws of heredity

Choose the correct answer from the options given below.
(a) A-3, B-2, C-1 (b) A-1, B-2, C-3
(c) A-2, B-3, C-1 (d) A-3, B-1, C-2

53. Which of the following statements are correct?
(i) Family planning programmes were initiated in 1951.
(ii) According to WHO, reproductive health means total well beings in the physical, social, behavioural and emotional aspects of reproduction.
(iii) '*Saheli*' was developed at CDRI in Lucknow.
(iv) Amniocentesis should not be banned as it is a fetal sex determination test.
(a) (i) and (ii) only (b) (ii) and (iii) only
(c) (i), (ii) and (iii) (d) (iii) and (iv) only

54. The sex of the baby is determined by the
(a) father, not by the mother
(b) mother, not by the father
(c) both mother and father
(d) mostly by mother, sometimes by father.

55. It is a diagrammatic sectional view of male reproductive system. Identify common duct which forms from the fusion of duct of seminal vesicle and vas deferens.



(a) A (b) B (c) D (d) C

56. "Spermiogenesis" is a process in which
(a) spermatids change into spermatozoa
(b) spermatogonia produce a spermatid
(c) spermatocytes give rise to spermatozoa
(d) dormant spermatozoa become active just before ejaculation.

57. The specific event and probable time of its occurrence is given below in mya. Find the incorrect match.
(a) 500 mya – Evolution of invertebrates
(b) 2000 mya – First cellular form of life
(c) 350 mya – Evolution of jawless fishes
(d) 450 mya – Evolution of sea weeds and some plants

58. Identify the correct statement(s).
I. Infertility is the inability to produce viable offspring due to the defects in the female partner only.
II. As long as the mother breast feeds to child fully, chances of conception are almost nil.
III. Spreading awareness can help to create a reproductively healthy society.
(a) II only (b) I, II and III
(c) II and III (d) I and III

59. Match List I with List II.

	List I		List II
A.	Vector borne diseases	(1)	Pneumonia
B.	Airborne diseases	(2)	Malaria
C.	Through contaminated food and water	(3)	Ringworm
D.	Fungal disease	(4)	Typhoid

Choose the correct answer from the options given below.

	A	B	C	D
(a)	2	1	4	3
(b)	1	4	3	2
(c)	4	2	1	3
(d)	2	1	3	4

60. How can allergy be diagnosed in a person?
(a) Presence of large amount of IgE antibodies in the blood.
(b) Presence of large number of bacteria in the blood.
(c) Presence of bilirubin and bilirubin pigments in the stool.
(d) Presence of sickle shaped RBCs in the blood.

61. Which one of the following statements is incorrect about menstruation?
(a) At menopause in the female, there is especially abrupt increase in gonadotropic hormones.
(b) The beginning of the cycle of menstruation is called menarche.
(c) During normal menstruation endometrium is shed off.
(d) The menstrual fluid can easily clot.

62. **Assertion :** Opioids are drugs derived from *Papaver somniferum*.

Reason : Opioids slow down metabolism and causes hallucinations.

(a) Both assertion and reason are correct and reason is the correct explanation of assertion.
(b) Both assertion and reason are correct but reason is not the correct explanation of assertion.
(c) Assertion is correct but reason is not correct.
(d) Assertion is not correct but reason is correct.

63. Match List I with List II.

	List I		List II
A.	Coelomate animal	(i)	Aschelminthes
B.	Pseudocoelomate animal	(ii)	Platyhelminthes
C.	Acoelomate animal	(iii)	Hemichordates
		(iv)	Arthropods
		(v)	Molluscs

Choose the correct answer from the options given below:

(a) A-(iii, iv, v), B-(i), C-(ii)   (b) A-(ii), B-(i), C-(iii, iv, v)
(c) A-(i), B-(ii), C-(iii, iv, v)   (d) A-(iii, iv), B-(ii, v), C-(i)

64. The basic rhythm of breathing is under the control of

(a) pneumotaxic centre of medulla
(b) breathing centre of medulla
(c) breathing centre of pons and medulla both
(d) centres of pons mainly, medulla centre upto some extent.

65. The brain of frog is divided into forebrain, midbrain and hindbrain. Which of the following is found in the forebrain of a frog?

(a) optic and olfactory lobes
(b) paired diencephalon and unpaired cerebral hemisphere
(c) olfactory lobes, paired cerebral hemisphere and unpaired diencephalon
(d) both (a) and (b).

66. The major difference between blood and lymph is that

(a) blood has RBCs and WBCs, while lymph has no WBCs
(b) blood has RBCs and WBCs, while lymph has only WBCs
(c) blood has WBCs, while lymph has RBCs
(d) blood has dissolved salts, while lymph has no such salts.

67. Metastasis is

(a) a part of regeneration
(b) transfer of cancer cells from one part of the body to another
(c) inhibition of uncontrolled growth
(d) all of these.

68. Micturition is

(a) removal of urea from blood
(b) removal of uric acid
(c) act of passing out urine
(d) removal of fats.

69. Resemblance between widely different groups due to a common ancestry is

(a) parallel evolution   (b) divergent evolution
(c) convergent evolution   (d) retrogressive evolution.

70. Digestion in cnidarians is ___________.

(a) extracellular   (b) intercellular
(c) intracellular   (d) both (a) and (c)

71. Striated muscles are primarily involved in

A. locomotory actions
B. changes in body postures
C. transportation of food through digestive tract
D. transport of gametes through genital tract.

(a) A, B   (b) B, C
(c) C, D   (d) A, D

72. Given below are two statements.

Statement I : Articulation between the occipital condyles and the atlas vertebra forms a hinge joint.

Statement II : Hinge joint allows considerable movement.

In the light of the above statements choose the correct answer from the options given below.

(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

73. Which of the following is correct regarding osteoporosis?

(a) Bone mass decreases
(b) Level of estrogen increases
(c) Level of estrogen decreases
(d) Both (a) and (c)

74. Match List I with List II.

	List I		List II
A.	Cardiac cycle	I.	72/min
B.	Plasma	II.	120/80 mmHg
C.	Systolic/Diastolic	III.	0.8 seconds
D.	Haemoglobin	IV.	12-16 gms in every 100 mL of blood
E.	Heart beat	V.	55% of the blood

Choose the correct answer from the options given below.

(a) A-I; B-II; C-III; D-IV; E-V
(b) A-III: B-V; C-II; D-IV; E-I
(c) A-III, B-I; C-V; D-II; E-I
(d) A-V; B-IV; C-III; D-I; E-II

75. Each human limb is made up of

(a) 60 bones   (b) 50 bones
(c) 40 bones   (d) 30 bones.

76. The cranial and spinal nerves are included under

(a) automonic nervous system
(b) peripheral nervous system
(c) central nervous system
(d) cutaneous nervous system.

77. What happens in high blood pressure?
(a) Heart diseases
(b) Affect vital organs
(c) Makes the lumen of arteries narrower
(d) Both (a) and (b)

78. The hormone, which is related to the urine concentration in mammals is
(a) antidiuretic hormone (b) testosterone
(c) oxytocin (d) thymosin.

79. Type of neuron in which cell body has only one axon is
(a) unipolar (b) bipolar
(c) multipolar (d) pseudounipolar.

80. In male frog, cloaca is mainly involved in passing which of the following?
(a) Sperms (b) Urine
(c) Faecal matter (d) All of these.

81. The greyish appearance of gray matter is due to
(a) myelinated fibres
(b) non-myelinated fibres
(c) concentrated neuron cell bodies
(d) both (b) and (c).

82. The conditions which are favourable for the formation of oxyhaemoglobin are
(a) $pO_2\uparrow$, $pCO_2\uparrow$, H^+conc.$\downarrow$, Temperature $\downarrow$
(b) $pO_2\downarrow$, $pCO_2\downarrow$, H^+conc.$\uparrow$, Temperature$\uparrow$
(c) $pO_2\uparrow$, $pCO_2\downarrow$, H^+conc. $\downarrow$, Temperature $\downarrow$
(d) $pO_2\downarrow$, $pCO_2\downarrow$, H^+conc. $\downarrow$, Temperature $\downarrow$

83. Which one of the following is correct with reference to haemodialysis?
(a) Absorbs and resends excess of ions.
(b) The dialysis unit has a coiled cellophane tube.
(c) Blood is pumped back through an artery after haemodialysis.
(d) Nitrogenous wastes are removed by active transport.

84. Neurohypophysis releases
(a) vasopressin
(b) oxytocin
(c) oxytocin and prolactin
(d) both (a) and (b).

85. Inspiratory capacity includes
(a) tidal volume + expiratory reserve volume
(b) expiratory and inspiratory reserve volume
(c) tidal volume + inspiratory reserve volume
(d) residual volume + expiratory reserve volume.

86. Match List I with List II.

	List I		List II
A.	Aravalli Hills	(i)	Karnataka
B.	Sarguja	(ii)	Rajasthan
C.	Western Ghats	(iii)	Meghalaya
D.	Khasi and Jaintia Hills	(iv)	Madhya Pradesh

Choose the correct answer from the options given below.
(a) A – (i), B – (ii), C – (iii), D – (iv)
(b) A – (ii), B – (iv), C – (i), D – (iii)
(c) A – (iii), B – (i), C – (ii), D – (iv)
(d) A – (ii), B – (iii), C – (iv), D – (i)

87. Receptors for protein hormones are located in cell in/on
(a) cell surface (b) ER
(c) cytoplasm (d) nucleus.

88. ADH or vasopressin is
(a) enzyme that hydrolyses peptides
(b) hormone secreted by pituitary that promotes reabsorption of water from glomerular filtrate
(c) hormone that promotes glycogenolysis
(d) energy rich compound connected with muscle contraction.

89. Pineal gland of human brain secretes melatonin concerned with
(a) anger
(b) male sexual behaviour
(c) pupil dilation
(d) sleep-wake cycle.

90. Eye lids and eye lashes are formed by the end of
(a) 1st month (b) 2nd month
(c) 5th month (d) 6th month.

SOLUTIONS

1. **(c) :** Ecosystem diversity is the variety of ecosystem which indicates diversity in the number of niches, trophic levels, food webs, nutrient cycles and ecological processes sustaining energy flow.

2. **(c) :** The synergids are characterised by the presence of filiform apparatus at the micropylar tip. It is in the form of finger like projections. Each projection consisting a core of microfibrils enclosed in a sheath. It guides pollen tube from synergid to egg.

3. **(c) :** Bacteriophage has ability to replicate within bacterial cell independent of control of bacterial chromosomal DNA.

4. **(a) :** Due to limited resources, increased competition and environmental resistance, the population fluctuates when it reaches the carrying capacity.

5. **(c) :** According to Mendel's law of dominance, in heterozygous individuals a character is represented by two contrasting factors called alleles or allelomorphs which occur in pairs. Out of the two contrasting alleles, only one is able to express its effect in the individual. It is called dominant factor or dominant allele. The other allele which does not show its effect in the heterozygous individual is called recessive factor or recessive allele.

6. **(c) :** During the process for the isolation of DNA, after several treatments the purified DNA is precipitated by adding chilled ethanol. The bacterial, plant and fungal cell is broken down by enzymes to release DNA, along with RNA,

proteins, polysaccharide and lipids. Lysozyme, cellulase and chitinase respectively.

7. **(d)**

8. **(a) :** The primary effluent formed is passed into large aeration tank where it is constantly agitated mechanically and the air is pumped into it. This allows vigorous growth of useful aerobic microbes into flocs *i.e.*, (masses of bacteria associated with fungal filaments to form a mesh-like structure. These microbes consume the major part of the organic matter in the effluent.

9. **(b)**

10. **(c) :** Meristems like apical and axillary are free from viruses.

11. **(c) :** Yeast used in baking and in alcoholic beverages is a type of eukaryotic fungus. Streptokinase is an enzyme obtained from the cultures of some haemolytic bacterium *Streptococcus* and modified genetically to function as clot busters. Lipases are lipid dissolving enzymes that are obtained from *Candida lipolytica* and *Geotrichum candidum*. They are added in detergents for removing oily stains from laundry. Pectinases along with proteases are used in clearing fruit juices.

12. **(d) :** In gel electrophoresis, the sample is loaded in the wells and towards the negative electrode.

13. **(c) :** In angiosperms, the body of the ovule consists of a mass of parenchymatous cells called nucellus. In the hypodermal region of nucellus towards the micropylar end develops a primary archesporial cell, which by further divisions forms a diploid megaspore mother cell. The latter undergoes meiosis to form megaspore tetrad. Usually the chalazal megaspore remains functional while the other three degenerate. The functional megaspore is the first cell of female gametophyte (embryo sac).

14. **(b)**

15. **(a) :** *B. thuringiensis* forms some protein crystals. These crystals contain a toxic inactive insecticidal protein. When an insect ingests it, it is converted into an active form of toxin. The activated toxin binds to the surface of midgut epithelial cells and create pores that causes swelling and lysis and finally cause death of the insect.

16. **(b) :** Independent assortment of genes takes place only when they are located on separate non-homologous chromosomes. When two or more than two genes are linked and located on same chromosome, independent assortment will not be possible.

17. **(a) :** In nature, predators are prudent because if a predator is too efficient and overexploits its prey, then the prey might become extinct and following it, the predator will also become extinct due to lack of food.

18. **(d) :** In gel electrophoresis DNA fragments move towards the anode according to their molecular size through the agarose gel. The separated DNA fragments can be observed only after staining them with ethidium bromide. The bright orange coloured bands of DNA can be seen only under UV light. These bands of DNA fragments are cut out from the gel and extracted by technique is called elution.

19. **(c) :** Roquefort cheese is formed by ripening with the fungi *Penicillium roqueforti* for a particular flavour.

20. **(b) :** When a species become extinct, the plant and animal species associated with it in an obligatory way also become extinct, this shows an example of co-extinction.

21. **(c) :** No population can continue to grow exponentially, as the resource availability become limiting at certain point of time. Logistic growth model have fixed carrying capacity.

It is described by the equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$ where,

$\frac{dN}{dt}$ = Rate of change of population density.

N = Population density

r = Intrinsic rate of natural increase

K = Carrying capacity

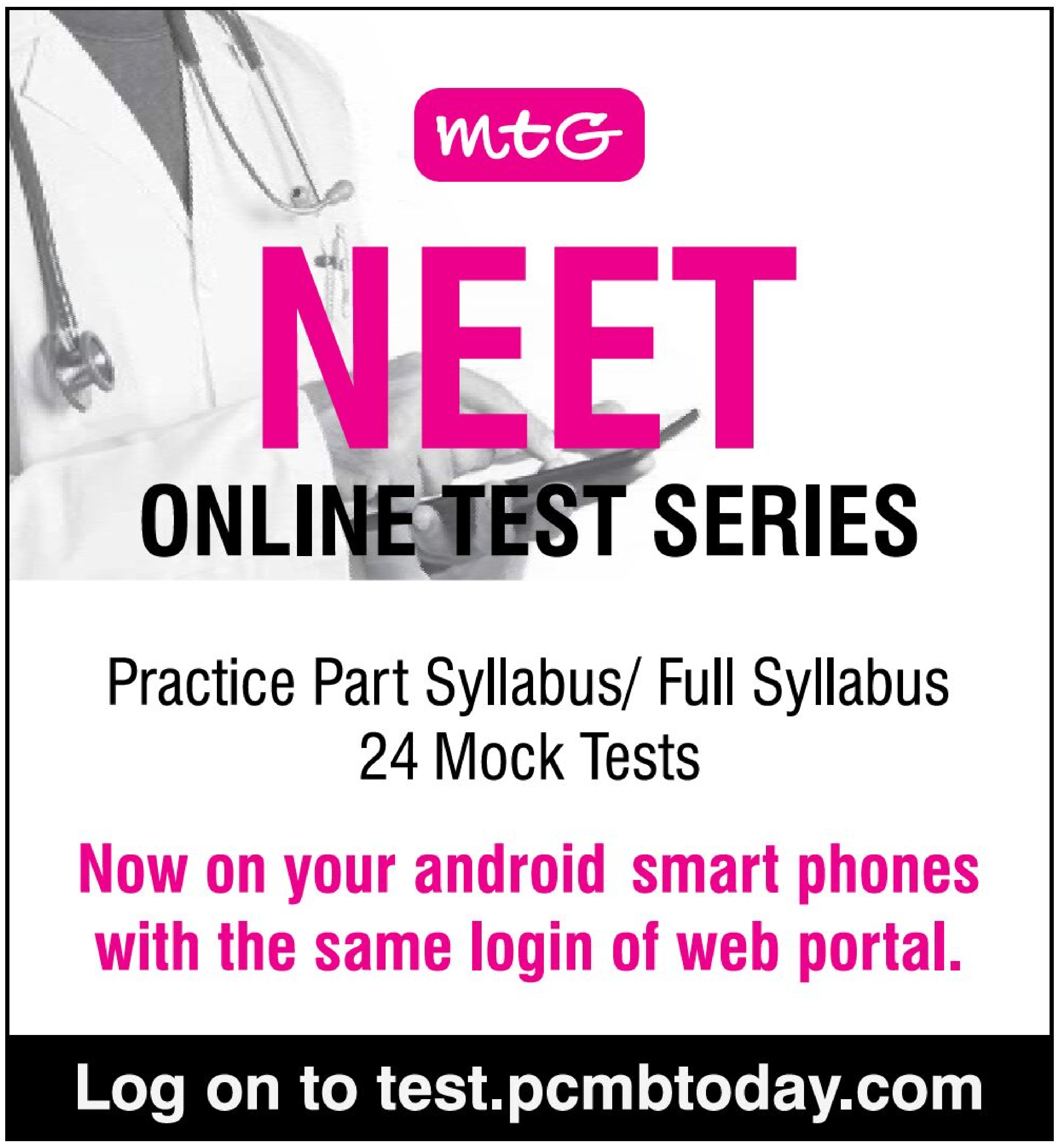
22. **(b)**

23. **(a)**

24. **(a) :** Yeast (*Saccharomyces cerevisiae*) is used for fermenting malted cereals and fruit juices (form of sugar) to produce ethanol.

25. **(a) :** UAA, UAG and UGA are stop codons. There are no *t*RNAs for stop codon.

26. **(b) :** Glycolysis is also known as EMP pathway after the names of its discoverers, Embden, Meyerhof and Parnas.



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In glycolysis, 8ATP are produced. 4ATP are formed from substrate level phosphorylation, out of which 2ATP are used up and net gain of 2ATP. 6ATP are produced from oxidative phosphorylation. Hence, total ATP produced in glycolysis is 8ATP.

27. (a)

28. (c) : When a flower has both androecium and gynoecium. It is said to be bisexual.

29. (d) **30. (b)** **31. (a)** **32. (a)**

33. (a) : *Euglena* possesses the characteristics of both plant and animal. It has chlorophyll, thus it is autotrophic like plants. In contrast to this, it has flagellated locomotion like animals.

34. (a) : Glycolysis occurs in cytoplasm, thus its enzymes are present in cytoplasm.

35. (d) : In dicotyledonous leaves, the mesophyll tissue is differentiated into the palisade and spongy parenchyma but in monocot such differentiation is not seen.

36. (c) : Most oxygen-producing photosynthetic cells contain two kinds of chlorophyll, of which one is always chlorophyll *a*. Photosynthetic cells that produce no oxygen that do not contain chlorophyll *a*. Eukaryotic photosynthetic organism contain chlorophyll but photosynthetic bacteria are prokaryotes. They do not produce oxygen and hence do not contain chlorophyll *a*.

37. (b) : In *Cycas*, stems are unbranched and other members like *Pinus* and *Cedrus* have branched stems. *Sphagnum* and *Gelidium* are algae which do not possess stems.

38. (a) **39. (d)**

40. (d) : The primary cell wall contains many small openings or pores situated in primary pit fields. The cytoplasm of adjacent cells communicates through the pores by means of cytoplasmic bridges called plasmodesmata. The plasmodesmata permit circulation of fluids and passage of solutes between cells.

41. (b) **42. (b)**

43. (b) : Bryophytes are called amphibians of plant kingdom because they complete their vegetative phase on land but water is necessary for their reproductive phase. Water helps in maturation and dehiscence of sex organs in bryophytes. It also helps in the transfer of sperms to the archegonium that make water essential for completion of life cycle of bryophytes.

44. (c) : Lecithin is a phospholipid composed of choline and inositol. It is found in all living cells as a major component of cell membrane.

45. (d) : In monocotyledons, the food is commonly stored inside the endosperm. But in the orchids, the seeds are non-endospermic.

46. (b) : I-Endometrium, II-Perimetrium, III-Infundibulum, IV-Fimbriae, V-Cervix, VI-Vaginal canal

47. (a) : Hepatitis-B is an infectious disease caused by the hepatitis-B virus (HBV) which affects the liver. HIV (human immunodeficiency virus) is a virus that attacks the immune system, the body's natural defense system. Without a strong immune system, the body has trouble fighting off disease. Both the diseases can also be transmitted by sharing of injection needles, surgical instruments, etc., with infected persons, transfusion of blood, or from an infected mother to the foetus too.

48. (a) : The ADA gene provides instructions for producing the enzyme adenosine deaminase. This enzyme is produced in all cells, but the highest levels of adenosine deaminase occur in immune system cells called lymphocytes, which develop in lymphoid tissues. Lymphocytes form the immune system, which defends the body against potentially harmful invaders, such as viruses or bacteria.

49. (b)

50. (a) : Sickle cell anaemia is not a sex linked (*i.e.*, X linked) disease but an autosomally inherited recessive trait. Haemophilia is X-linked but not holandric/Y-linked. Klinefelter's syndrome is caused due to presence of additional copy of X chromosome resulting into a karyotype of 47, XXY.

51. (d) : *Homo habilis* was first human-like hominid, The brain capacity of *Homo habilis* were between 650-800 cc.

52. (a) **53. (c)**

54. (a) : 50% of sperms have X chromosome and 50% have Y chromosome. If Y chromosome containing sperm fertilises the egg, male baby will develop and when X chromosome containing sperm fertilises the egg, female baby will develop.

55. (a) : A-Ejaculatory duct, B-Ureter, C-Vas deferens, D-Urethra. Ejaculatory duct is formed by the fusion of duct of vas deferens and seminal vesicle.

56. (a) : The spermatids are transformed into spermatozoa by process called spermiogenesis.

57. (d) : Sea weeds and few plants existed around 320 mya.

58. (c) : Infertility is the inability to produce viable offspring due to the defects in female or male partner.

59. (a)

60. (a) : Allergies mainly involve IgE antibodies and chemicals like histamine and serotonin from mast cells. IgE antibodies are produced in response to an antigen, mast cells and basophils.

61. (d) : Menstruation is a process which involves discharge of blood (45 – 100 mL), serous fluid, cell debris and mucosal fragments from cast off endometrial lining due to reduced titre of both estrogen and progesterone hormone. Blood clotting does not occur due to presence of fibrinolysin.

62. (c) **63. (a)**

64. (b) : Dorsal group of neuron in medulla sets basic rhythm of respiration.

65. (c) : The forebrain of frog comprises of olfactory lobes, paired cerebral hemispheres and unpaired diencephalon.

66. (b) : Lymph has only white blood cells (WBCs) so the colour of lymph is white (RBCs are not present in lymph), while blood has RBCs, WBCs, blood plasma and platelets.

67. (b) : Metastasis is spread of cancer cells from place where they first formed to another part of body.

68. (c) **69. (b)**

70. (d) : Digestion in cnidarians is both extracellular and intracellular.

71. (a)

72. (c) : Articulation between the occipital condyles and the atlas vertebra forms a pivot joint.

73. (d) : Osteoporosis is an age-related disorder in which bone mass get decreased and chances of a fracture increases. Decreased level of estrogen is a common cause.

74. (b)

75. (d) : Limbs of humans consist of 30 bones, *i.e.*,

Total bones $=30\times4=120$ bones (forelimb and hindlimb).

76. (b)

77. (d) : High blood pressure causes heart diseases and affects vital organs such as kidney and brain.

78. (a) : ADH or antidiuretic hormone (or vasopressin) is produced by hypothalamus and stored in posterior pituitary. As the name suggests, it is an anti-diuretic (diuresis means excessive production of urine) hormone. So, ADH causes decreased urine production by causing reabsorption of water in regions of DCT and also in collecting tubules resulting in concentration of urine and dilution of plasma.

79. (a) : Unipolar neurons have one axon only. They are found in embryonic stage.

80. (d) : In male frogs, cloaca is a small median chamber that is used to pass sperms, faecal matter and urine to the exterior.

81. (c) **82. (c)**

83. (b) : Haemodialysis is done in the patients whose kidneys become completely non-functional. Haemodialysis is the process of diffusion across a semipermeable membrane to remove unwanted substances from the blood while adding desirable components. The dialysis unit consists of a coiled cellophane tube kept in the dialysing fluid. The membrane of the tube is impermeable to blood cells and proteins but permeable to urea, uric acid, creatinine and mineral ions.

84. (d)

85. (c) : Volume of air that can be inspired after normal expiration is inspiratory capacity. It is sum of tidal volume and inspiratory reserve volume.

86. (b) **87. (a)**

88. (b) : Antidiuretic hormone (ADH) or vasopressin is released by the posterior lobe of the pituitary gland. It increases the reabsorption of water in the distal convoluted tubule, collecting tubules and collecting ducts of the nephrons of the kidneys. As a result, the reabsorption of water from the glomerular filtrate is increased. Enzyme that hydrolyses peptides is known as peptidase. Hormones that promotes glycogenolysis is glucagon and adrenaline. Energy rich compound connected with muscle contraction is ATP.

89. (d) : Pineal secretes a hormone called melatonin. Melatonin plays a very important role in the regulation of a 24-hour (diurnal) rhythm of our body. For example, it helps in maintaining the normal rhythms of sleep-wake cycle, body temperature, etc.

90. (d) ☺☺

INFO SHOTS

Why Do Leaves Change Colour?

As days grow shorter and temperatures cooler, deciduous trees prepare for winter dormancy. Lacking sufficient light and water, photosynthesis shuts down and trees must live off food stored during the growing season.

In spring, leaves lay the ground work for their demise. A special layer of cells forms at the base of each leaf, called the abscission or separation layer. Its work is to transport water to the leaf and take food, created by photosynthesis, back to the tree.

In autumn, the cells of this layer begin to swell and the bottom of this layer forms a cork like substance that eventually cuts off all transfer between leaf and tree. Meanwhile, the top of the layer begins to disintegrate, making it easy for the leaf to detach.

As photosynthesis ceases, the leaves lose their chlorophyll, which gives them their green color. Without chlorophyll, other colours emerge. Yellow and orange, for example, are normally present in the leaves but are overshadowed by the chlorophyll.

Maple-leaf red occurs because glucose remains when photosynthesis shuts down. Drab oak-leaf brown represents wastes left in the leaves.

Class 12

CBSE

SOLVED PAPER 2025

Held on 25th March

Hurray!! We are happy to inform our readers that in CBSE 2025 Biology question papers more than 90% questions were either exactly same or of similar type from **MTG Books**.

The references of few questions of paper having code - 057/2/3 are given here :

Paper Q. No.	P. No.	Q. No.	MTG Book
6	107	16	CBSE Champion Biology Class-12
7	148	83	CBSE Champion Biology Class-12
8	99	6	CBSE Champion Biology Class-12
9	217	25	CBSE Champion Biology Class-12
15	194	1	Objective NCERT at your Fingertips
17(a)	9	30, 33	CBSE Champion Biology Class-12
17(b)	942	9	100 Percent Biology
19(b)	383	19(a)	CBSE Champion Biology Class-12
20(a) (b)	276	51(a), (b)	CBSE Champion Biology Class-12
21	367	14	CBSE Champion Biology Class-12
22(a)	79	11	CBSE Champion Biology Class-12
24	192	57	CBSE Champion Biology Class-12
23(b)	15	15	100 Percent Biology
26	222	82	CBSE Champion Biology Class-12
28(a) (b)	367	15	CBSE Champion Biology Class-12
31(a)	45	26	CBSE Champion Biology Class-12
31(b)	16	27	100 Percent Biology
32(a)	296	18	CBSE Champion Biology Class-12
32(b)	319	15	CBSE Champion Biology Class-12

and many more ……

Time Allowed : 3 hours
Maximum Marks : 70

General Instructions :

Read the following instructions carefully and follow them :

- *(i) This question paper contains **33** questions. **All** questions are **compulsory**.*
- *(ii) Question paper is divided into **five** sections – Sections **A**, **B**, **C**, **D** and **E**.*
- *(iii) **Section A** – questions number **1** to **16** are multiple choice type questions. Each question carries **1** mark.*
- *(iv) **Section B** – questions number **17** to **21** are very short answer type questions. Each question carries **2** marks.*
- *(v) **Section C** – questions number **22** to **28** are short answer type questions. Each question carries **3** marks.*
- *(vi) **Section D** – questions number **29** and **30** are case-based questions. Each question carries **4** marks. Each question has subparts with internal choice in one of the subparts.*
- *(vii) **Section E** – questions number **31** to **33** are long answer type questions. Each question carries **5** marks.*
- *(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for only **one** of the alternatives in such questions.*
- *(ix) Wherever necessary, neat and properly labelled diagrams should be drawn.*

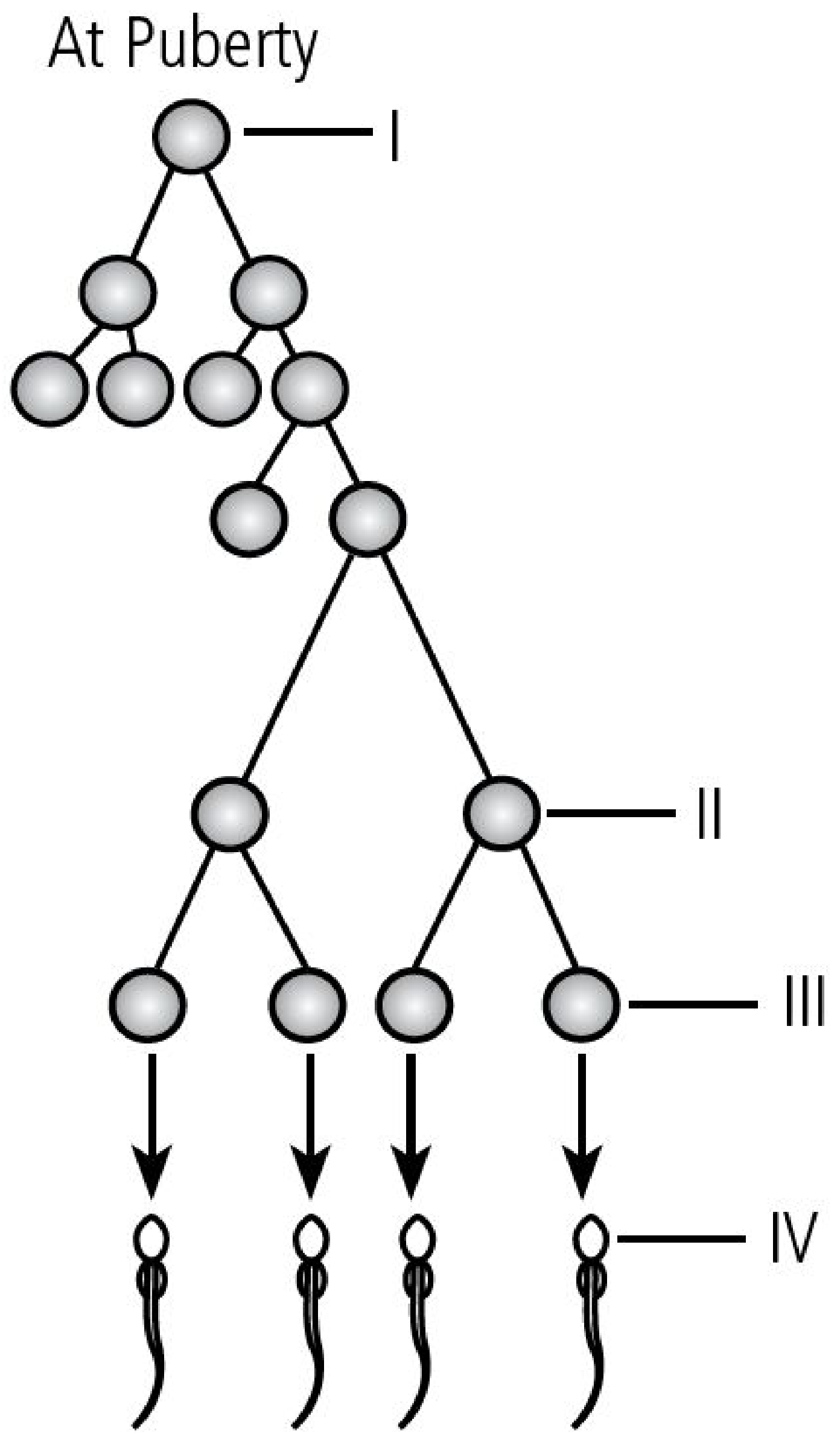
SECTION-A

Question Nos. 1 to 16 are Multiple Choice Questions, carrying 1 mark each.

1. Some flowers are unisexual, this property of unisexuality of flowers prevents which kind of pollination?
(a) Both autogamy and geitonogamy
(b) Both geitonogamy and xenogamy
(c) Geitonogamy but not xenogamy
(d) Autogamy but not geitonogamy

2. Given below is the schematic representation of spermatogenesis in human males:

Choose the option that shows the correct labelling of 'I', 'II', 'III' and 'IV' in the given diagram.

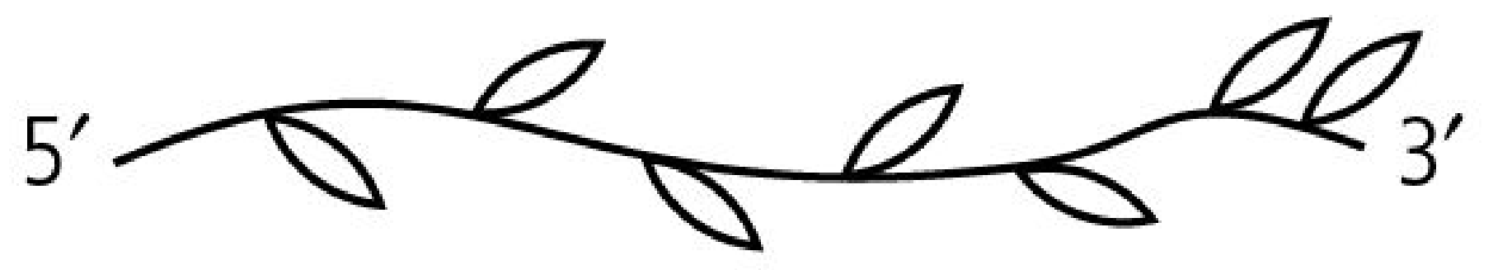


	I	II	III	IV
(a)	Spermatozoa	Spermatid	Sec. spermatocyte	Spermatogonia
(b)	Spermatid	Spermatogonia	Sec. spermatocyte	Spermatozoa
(c)	Spermatogonia	Sec. spermatocyte	Spermatozoa	Spermatid
(d)	Spermatogonia	Sec. spermatocyte	Spermatid	Spermatozoa

3. Which one of the following options shows the correct evolutionary order of the plants mentioned below?
(i) Ferns
(ii) *Ginkgo*
(iii) *Zosterophyllum*
(iv) Gnetales
(a) (i), (iii), (ii), (iv)
(b) (iii), (i), (ii), (iv)
(c) (i), (ii), (iii), (iv)
(d) (iv), (ii), (i), (iii)

4. In molecular biology, who proposed that genetic information flows in one direction?
(a) Hargobind Khorana
(b) Francis Crick
(c) Watson and Crick
(d) Marshall Nirenberg

5. Given below is a heterogeneous RNA formed during eukaryotic transcription:



How many introns and exons respectively are present in the hnRNA?
(a) 7, 7
(b) 8, 7
(c) 8, 8
(d) 7, 8

6. Which of the following features correctly show the mechanism of sex-determination in honeybees?
(i) A zygote formed from the union of a sperm and an egg develops into a male.
(ii) Males have half the number of chromosomes as that of females.
(iii) The females are diploid having 32 chromosomes.
(iv) Males have a father and can produce sons.
Choose the correct option:
(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i) and (iv)
(d) (ii) and (iv)

7. Study the items of Column-I and those of Column-II.

	Column-I		**Column-II**
(A)	RNA polymerase I	(i)	18s rRNA
(B)	RNA polymerase II	(ii)	SnRNAs
(C)	RNA polymerase III	(iii)	hnRNA

Choose the option that correctly matches the items of column-I with those of column-II.

	(A)	**(B)**	**(C)**
(a)	(i)	(ii)	(iii)
(b)	(iii)	(ii)	(i)
(c)	(ii)	(iii)	(i)
(d)	(i)	(iii)	(ii)

8. A child with blood group A has father with blood group B and the mother with blood group AB. Choose the option that gives the correct genotypes of father, mother and the child.

	Father	**Mother**	**Child**
(a)	I^Ai	I^Bi	I^Ai
(b)	I^AI^B	I^Ai	I^AI^A
(c)	I^Bi	I^AI^B	I^Ai
(d)	I^BI^B	I^AI^B	I^AI^A

9. The decrease in the T-Lymphocytes count in human blood will finally result in
(a) decrease in antigens
(b) decrease in antibodies
(c) increase in antibodies
(d) increase in antigens.

10. If Meselson and Stahl's experiment is continued for 80 minutes (till III generation) then what would be the ratio of DNA containing $N^{15}/N^{15} : N^{15}/N^{14} : N^{14}/N^{14}$ in the medium?
(a) 1 : 1 : 0
(b) 0 : 1 : 3
(c) 0 : 1 : 8
(d) 1 : 4 : 0

11. Select the correct statement from the following biotechnological procedures.
(a) The polymerase enzyme joins the gene of interest and the vector DNA.
(b) Gel electrophoresis is used for amplification of a DNA segment.
(c) PCR is used for isolation and separation of gene of interest.
(d) Plasmid DNA acts as vector to transfer the piece of DNA attached to it.

12. For commercial and industrial production of citric acid, which one of the following microbes is used?
(a) *Aspergillus niger* (b) *Lactobacillus sp.*
(c) *Clostridium butylicum* (d) *Saccharomyces cerevisiae*

Question numbers 13 to 16 consists of two statements Assertion (A) and Reason (R). Answer these questions selecting the appropriate option as given below:
(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of the (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

13. **Assertion (A) :** Corpus luteum secretes the hormone, progesterone.
Reason (R) : Hormone progesterone is essential for maintenance of the endometrium.

14. **Assertion (A) :** The number of white winged moths decreased after industrialisation in England.
Reason (R) : Effects of industrialisation were more marked in rural areas of England.

15. **Assertion (A) :** *Streptococcus pneumoniae* and *Haemophilus influenzae* are responsible for causing infectious disease in human beings.
Reason (R) : A healthy person acquires the infection by inhaling the aerosols released by an infected person.

16. **Assertion (A) :** Restriction endonuclease recognises palindromic sequence in DNA and cuts them.
Reason (R) : Palindromic sequence has two unique recognition sites PstI and PvuI recognised by restriction endonuclease.

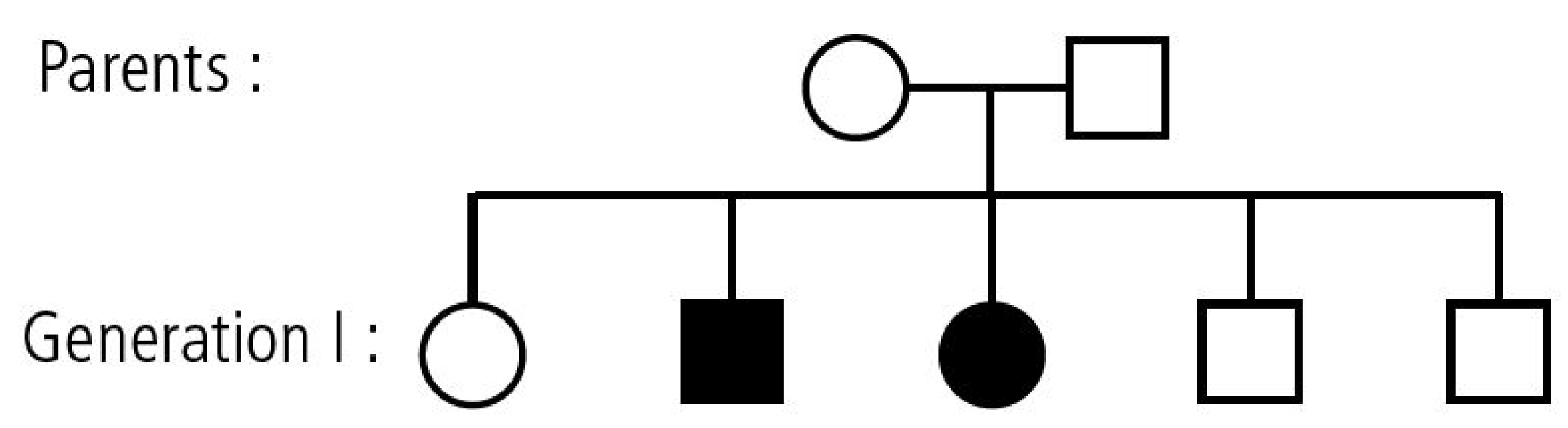
SECTION-B

17. *Student to attempt either option (a) or (b).*
(a) Comment upon the mode of pollination in *Vallisneria* and *Zostera*.

OR

(b) Mention any four strategies adopted by flowering plants to prevent self-pollination.

18. Study the given pedigree chart in which neither of the parents shows the trait but the trait is present in both male and female children.



Answer the following questions:
(a) Write about the trait, also explain the inheritance of such trait in the progeny on the basis of given pedigree chart.
(b) Give one example of such trait in human beings.

19. *Student to attempt either option (a) or (b).*
(a) Describe any two situations where a medical doctor would recommend injection of a pre-formed antibodies (antitoxins) into the body of a patient.

OR

(b) The symptoms of malaria do not appear immediately after the entry of sporozoites into the human body when bitten by female *Anopheles* mosquito. Explain why it happens.

20. **(a)** Write the scientific name of the source organism of the thermostable DNA polymerase used in PCR.
(b) State the advantage of using thermostable DNA polymerase.

21. State the conclusions derived by David Tilman's long term ecosystem experiments using outdoor plots.

SECTION-C

22. **(a)** List two reasons that make copper releasing IUDs as effective contraceptives.
(b) Explain how the intake of oral contraceptive pills prevent pregnancy in humans.

23. **(a)** A bilobed dithecous anther has 200 microspore mother cells per microsporangium. How many male gametophytes can be produced by this anther?
(b) Write the composition of intine and exine layers of a pollen grains.

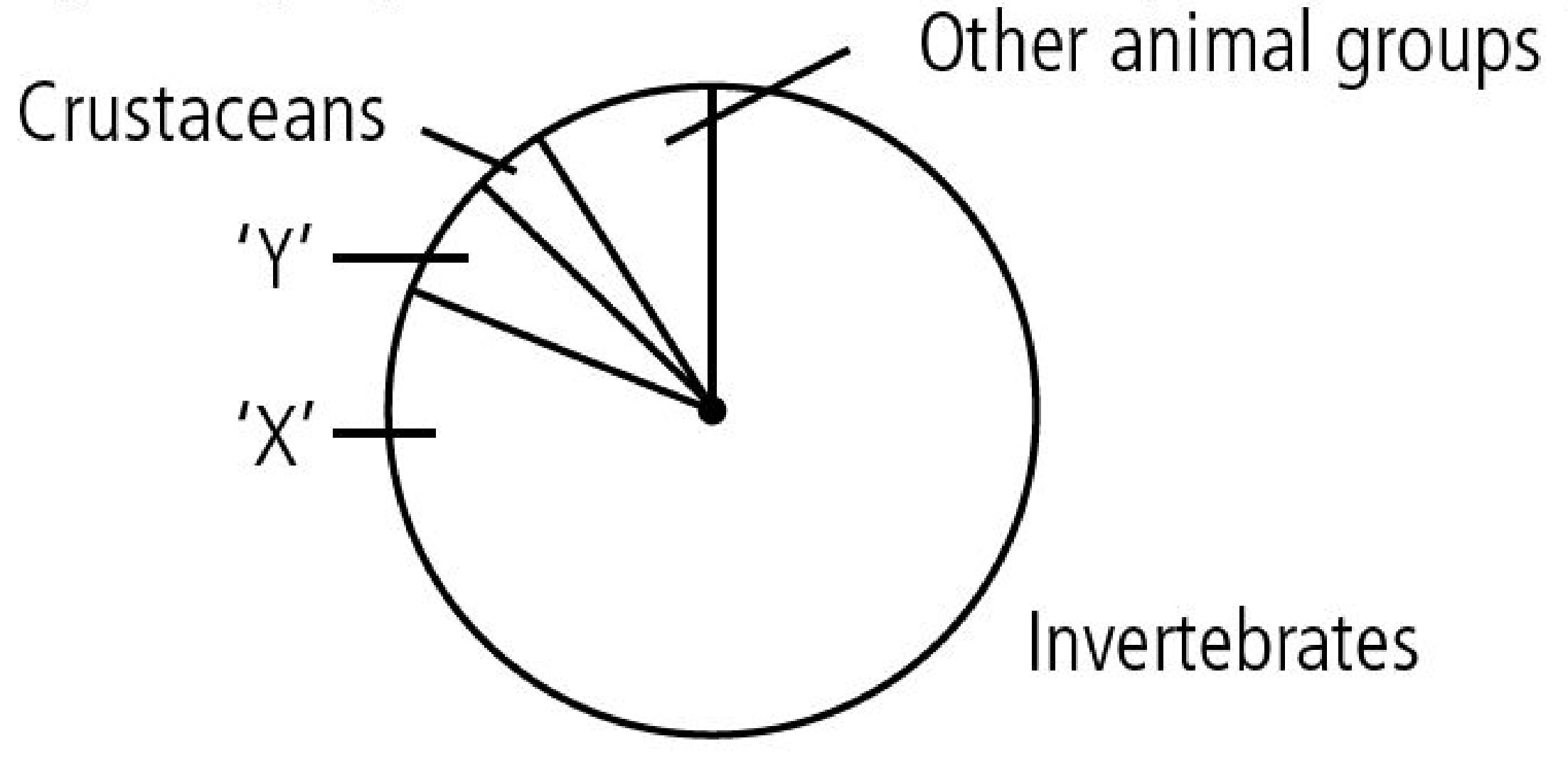
24. How does the process of natural selection affect Hardy-Weinberg equilibrium? Explain with the help of graphs.

25. Using a Punnett square workout the distribution of an autosomal phenotypic feature in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.

26. Samples of blood and urine of a sportsperson are collected before any sports event for drug tests.
(a) Why there is a need to conduct such tests?
(b) Name the drugs the authorities usually look for.
(c) Write the generic names of two plants from which these drugs are obtained.

27. An application of biotechnology in agriculture involves the production of pest resistant plants, using "*cry*" gene from a bacterium, *Bacillus thuringiensis.*
(a) Proteins coded by which specific Bt toxin gene control corn borer?
(b) How does Bt toxin produced by the bacterium kill the insect? Explain.

28. Study the pie chart given below, representing the global biodiversity and proportionate number of species of major taxa.



Answer the following questions:

(a) Identify 'X' and 'Y' in the given pie chart.

(b) Which one of the two 'X' or 'Y', is the most species-rich taxonomic group and by what percentage ?

(c) Name the level of biodiversity represented by the following :
  (i) Estuaries and alpine meadows in India
  (ii) The medicinal plant *Rauwolfia vomitoria*.

SECTION-D

Questions No. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

29. Immunity in our body is of two types : (i) Innate immunity and (ii) acquired immunity. Innate immunity is a non-specific defence mechanism, whereas acquired immunity is pathogen-specific; it is called specific immunity too. Acquired immunity is characterised by memory. Antibodies are specific to antigens and there are different types of antibodies produced in our body : they are IgA, IgE, IgG and IgM. It shows primary response when it encounters the pathogen for the first time and secondary response during the subsequent encounters with the same antigen/pathogen.

(a) Name the two types of specialised cells which carry out the primary and secondary immune response.

(b) Why is the antibody-mediated immunity also called as humoral immune response?

Attempt either sub-part (c) or (d):

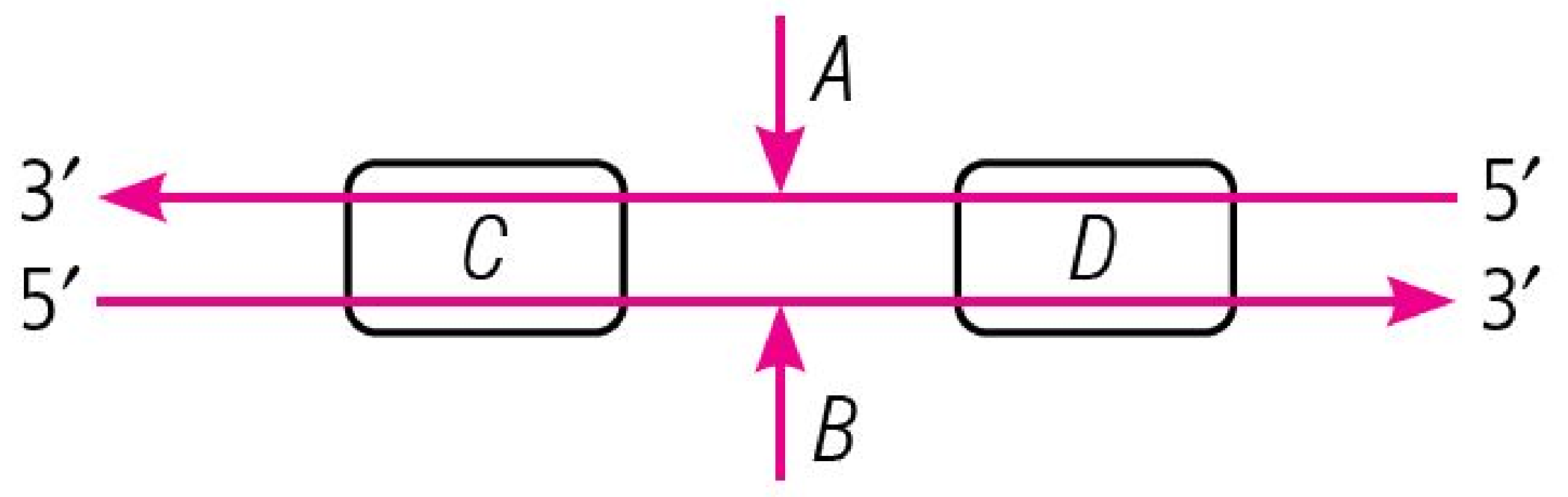
(c) The organ transplants are often rejected if not taken from suitable compatible persons.
  (i) Mention the characteristic of our immune system that is responsible for the graft rejection.
  (ii) Name the type of immune response and the cell involved in it.

OR

(d) How is active immunity different from passive immunity?

30. The process of copying the genetic information from one strand of DNA into RNA is termed as transcription. The principle of complementarity of bases governs the process of transcription, also except that uracil comes in place of thymine.

Study the complete transcription unit given below and answer the following questions:



(a) Name the main enzyme involved in the process of transcription.

(b) Identify coding strand and template strand of DNA in the transcription unit.

Attempt either sub-part (c) or (d) :

(c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.

OR

(d) Describe the location of (C) and (D) in the transcription unit.

SECTION-E

31. *Student to attempt either option (a) or (b)*.

(a) **(i)** Give a schematic representation of oogenesis in human females.

(ii) Mention the number of chromosomes at each stage. Correlate the life phases of the individual with the stages of the process.

OR

(b) **(i)** Describe the three types of pollination that can occur in a chasmogamous bisexual flower.
  (ii) Draw the diagram of a mature pollen grain released at the two celled stage and label four parts in it.

32. *Student to attempt either option (a) or (b)*.

(a) **(i)** Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.
  (ii) Explain the steps of amplification of gene of interest using PCR technique.

OR

(b) **(i)** What are transgenic animals?
  (ii) Why are these animals being produced? Explain any four reasons.

33. *Student to attempt either option (a) or (b)*.

(a) **(i)** Explain giving three reasons why tropics show greatest levels of species diversity.
  (ii) Draw a graph showing species-area relationship. Name the naturalist who studied such relationship. Write the observation made by him.

OR

(b) **(i)** The world is facing the accelerated rate of species extinctions due to human activities. Explain any three major causes of biodiversity losses.
  (ii) Describe '*Ex situ*' approach for conserving biodiversity. Give any two examples.

SOLUTIONS

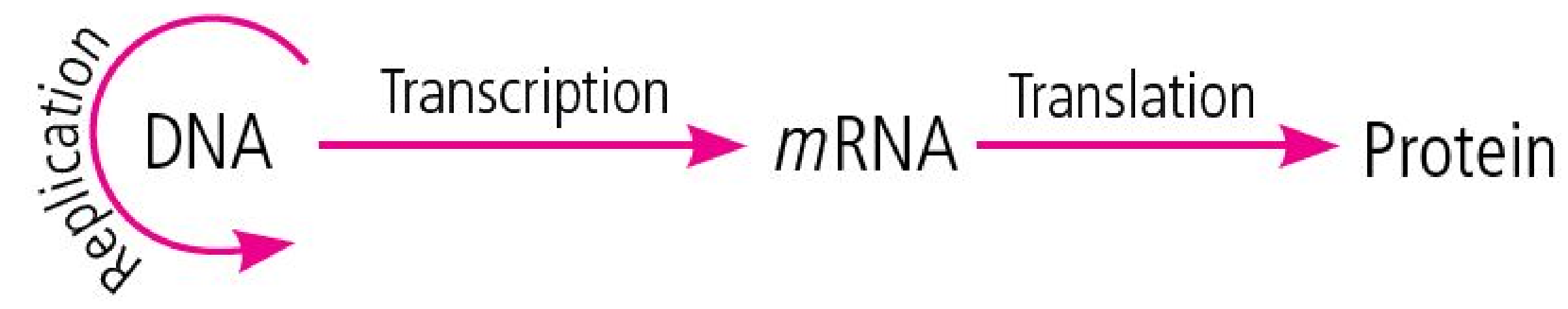
1. **(d) :** Unisexual flowers have only one reproductive organ, either male (staminate) or female (pistillate). The unisexual nature of these flowers prevents autogamy (self-pollination) because autogamy involves the transfer of pollen from the anther to the stigma of the same flower, which is not possible in unisexual flowers. However, unisexuality does not prevent geitonogamy, where pollen is transferred from the anther of one flower to the stigma of another flower on the same plant.

2. **(d)**

3. (b) : The correct evolutionary order of the plants is as below:

Zosterophyllum → Ferns → *Ginkgo* → Gnetales
(Silurian) (Jurassic) (Cretaceous) (Cretaceous)

4. (b) : Francis Crick proposed the idea of 'Central dogma' which states that the flow of genetic information is unidirectional and first occurs from DNA to *m*RNA by the process of transcription. Then the information present in *m*RNA is decoded for the formation of polypeptide chain by the process of translation.



5. (d) : A hnRNA is an unprocessed RNA which contains both exons (coding sequences) and introns (non-coding sequences). During splicing, the introns form a loop-like structure whereas the exons are joined together to form the final, mature *m*RNA. Therefore, in the diagram, the loop-like structures represent the introns (counted as 7), and the remaining sequences are the exons (counted as 8).

6. (b) : In honeybees, an offspring formed from the union of a sperm and an egg develops as a female (queen or worker) and the males do not have father and thus cannot have sons.

7. (d) : RNA polymerase I- 18s rRNA
RNA polymerase II- hnRNAs
RNA polymerase III- SnRNAs

8. (c)

9. (b) : Antibodies are immunoglobulins produced by B-lymphocytes of immune system in response to foreign proteins, called antigens. T-lymphocytes do not secrete antibodies themselves but help B-lymphocytes to produce them. So, the decrease in T-lymphocytes count results in the decrease in antibodies.

10. (b) : Meselson and Stahl's experiment shows that at each replication, one strand of parent DNA is conserved in the daughter strand while the second strand is freshly synthesised. The third generation in the experiment will contain no (zero) ^{15}N ^{15}N DNA fragment, 2 ^{15}N ^{14}N DNA fragments and 6 ^{14}N ^{14}N DNA fragments. Therefore, the ratio of ^{15}N ^{15}N : ^{15}N ^{14}N : ^{14}N ^{14}N fragments will be 0:1:3.

11. (d) : Enzyme DNA ligase acts on cut DNA molecules and joins their ends. Gel electrophoresis is used for the isolation and separation of gene of interest. PCR is used for the amplification of DNA segment.

12. (a) : *Aspergillus niger* (fungus) is used for the commercial and industrial production of citric acid. *Lactobacillus* (a bacterium) produces lactic acid, *Clostridium butylicum* (a bacterium) produces butyric acid and *Saccharomyces cerevisiae* (yeast) is used for commercial production of ethanol.

13. (b) : The corpus luteum secretes large amounts of hormone progesterone. This progesterone is essential for maintenance of the endometrium required for maintaining pregnancy.

14. (c) : After industrialisation in England, the tree trunks became dark due to industrial smoke and soots and the white-winged moth did not survive due to predators. This led to the decrease in the white winged moths. The effect of industrialisation was more marked in the urban cities compared to the rural areas where the count of melanic moths was found to be low.

15. (b) : Bacteria like *Streptococcus pneumoniae* and *Haemophilus influenzae* are responsible for the disease pneumonia in humans which is an infectious disease. A healthy person acquires the infection by inhaling the droplets/aerosols released by an infected person.

16. (c) : Each restriction endonuclease recognises a specific palindromic nucleotide sequence in the DNA and cuts them. Not all palindromic sequences have exactly two recognition sites, this varies depending on the DNA and the enzyme.

17. (a) Pollination in *Vallisneria* and *Zostera* is accomplished through water.

In *Vallisneria*, the female flower reaches the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water. They are carried passively by water currents and some of them eventually reach the female flowers and the stigma.

In *Zostera*, the female flowers remain submerged in water and pollen grains are released inside the water. Pollen grains in such species are long, ribbon-like and they are carried passively inside the water, some of them reach the stigma and achieve pollination.

OR

(b) The four strategies adopted by flowering plants to prevent self-pollination are:

(i) In some species, pollen release and stigma receptivity are not synchronised. Either the pollen is released before the stigma becomes receptive or stigma becomes receptive much before the release of pollen.

(ii) In some other species, the anther and stigma are placed at different positions so that the pollen cannot come in contact with the stigma of the same flower.

UNSCRAMBLED WORDS

APRIL 2025

1-f- NOTOCHORD
2-a-APOMIXIS
3-h-PERIGYNOUS
4-g-METHANOGENS
5-b- LYSOSOMES
6-i-SPERMIATION
7-j-ACROMEGALY
8-e-TRANSFORMATION
9-d-LEUCOCYTES
10-c-THALASSEMIA

Winner : *Jay Chauhan (Gurugram)*

(iii) The third device to prevent inbreeding is self-incompatibility. This is a genetic mechanism and prevents self-pollen (from the same flower or other flowers of the same plant) from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil.

(iv) Another device to prevent self-pollination is the production of unisexual flowers. If both male and female flowers are present on the same plant such as castor and maize (monoecious), it prevents autogamy but not geitonogamy.

18. **(a)** In the given pedigree, it is clearly indicated that neither of the parent is affected with the disease but both male and female children were affected. It is an example of autosomal recessive disorder which can be explained by the following:

(i) There is a chance of both sexes being affected equally. It indicates that the disease-causing gene is not linked to the sex chromosome but to the autosomes, therefore it is an autosomal disorder.

(ii) The affected male and female children from the unaffected parents indicate that the parents must be the carrier for disease, and thus the disease-causing gene is not expressed in them. Each affected child should have received a copy of gene from both the parents therefore, it is a recessive disorder.

(b) Sickle cell anaemia is an example of autosomal recessive disorder in human beings.

19. **(a)** Antitoxins (pre-formed antibodies) are preparation or injection containing antibodies to toxin. Antitoxins neutralises the pathogenic agents and give quick relief. Therefore, if a person is infected with some deadly microbes to which quick immune response is required, we need to directly inject the antitoxins. In case of tetanus and snakebites, quick neutralisation is required for quick relief, so antitoxins containing preformed antibodies against the tetanus and snake venom respectively are given. This type of immunisation is called passive immunisation.

OR

(b) The symptoms of malaria do not appear in a person immediately after being bitten by an infected female *Anopheles* because haemozoin toxin is not released from the red blood cells. The symptoms of disease could appear after a period of 14 days (depending on the type of malaria and pathogen days vary) when haemozoin is released in blood.

When the sporozoites reach the liver through blood, the parasite reproduces asexually in liver cells and then attack the RBCs. The red blood cells bursts and release haemozoin that causes cycles of fever, shivering and some other symptoms. Simultaneously, released parasites with haemozoin toxin infect new blood cells to make symptoms more visible.

20. **(a)** Bacterium, *Thermus aquaticus* is the source organism of the thermostable DNA polymerase (*Taq* polymerase) used in PCR.

(b) The advantage of using thermostable DNA polymerase is that they remain active at high temperature (about 90°C) and induced denaturation of double stranded DNA. Thus, it is used to synthesise the segment of DNA between the primers (extension) in polymerase chain reaction at high temperature.

21. David Tilman used outdoor plots to give experimental evidence of a stable community which are as follows:

(i) A plot with more species showed less year-to-year variation in trait biomass.

(ii) Increased diversity contributes to higher productivity.

22. **(a)** Copper releasing IUDs (CuT, Cu7, Multiload 375) are effective contraceptives as : (i) they increase phagocytosis of sperms within the uterus (ii) the copper ions released suppress sperm motility and fertilising capacity of sperms.

(b) Oral contraceptive pills act in following ways:

- Inhibition of ovulation.
- Inhibition of motility and secretory actions of oviducts.
- Alteration of uterine endometrium making it unsuitable for implantation.

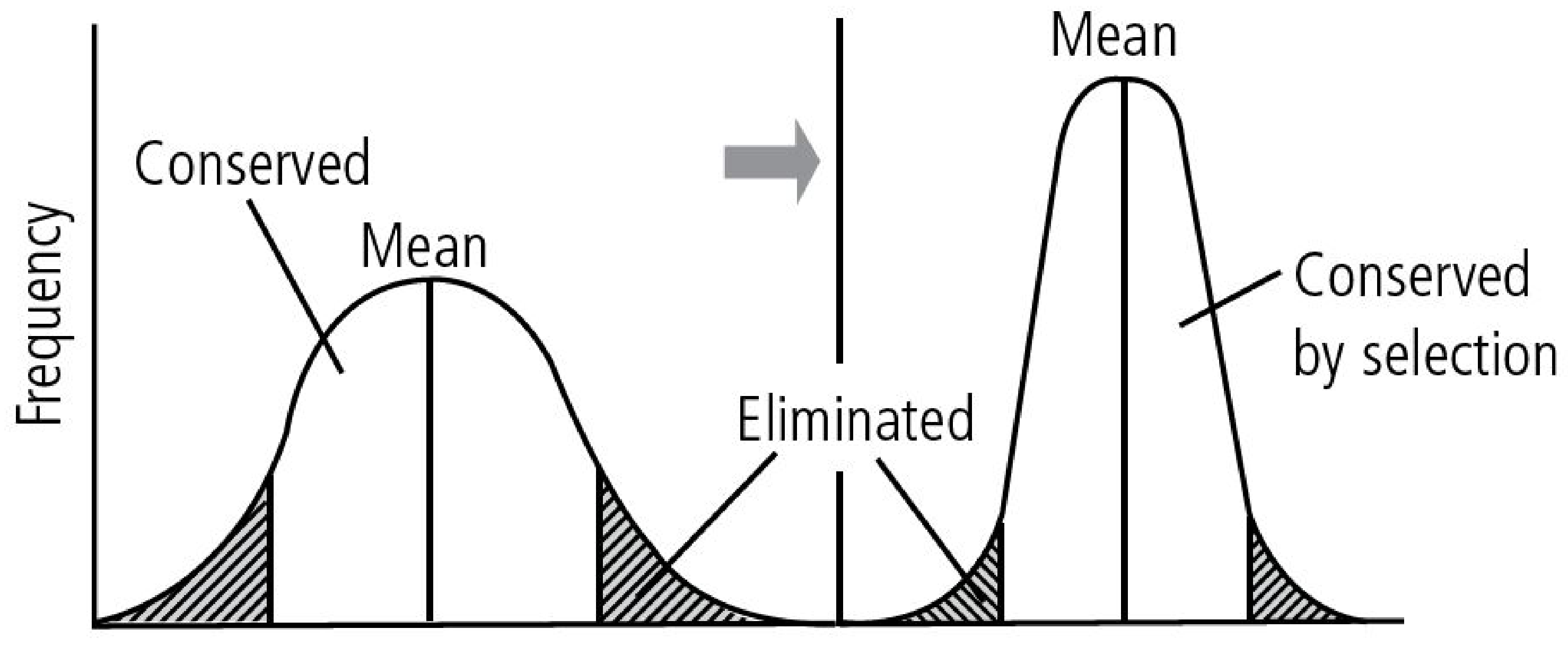
23. **(a)** Each microspore mother cell undergoes meiosis, producing 4 microspores (or pollen grains). Given 200 microspore mother cells per microsporangium and 4 microsporangia in a bilobed anther, total number of microspore mother cells are $200 \times 4 = 800$.

Each microspore mother cell produces 4 male gametophytes, so the total number of male gametophytes formed are $800 \times 4 = 3200$.

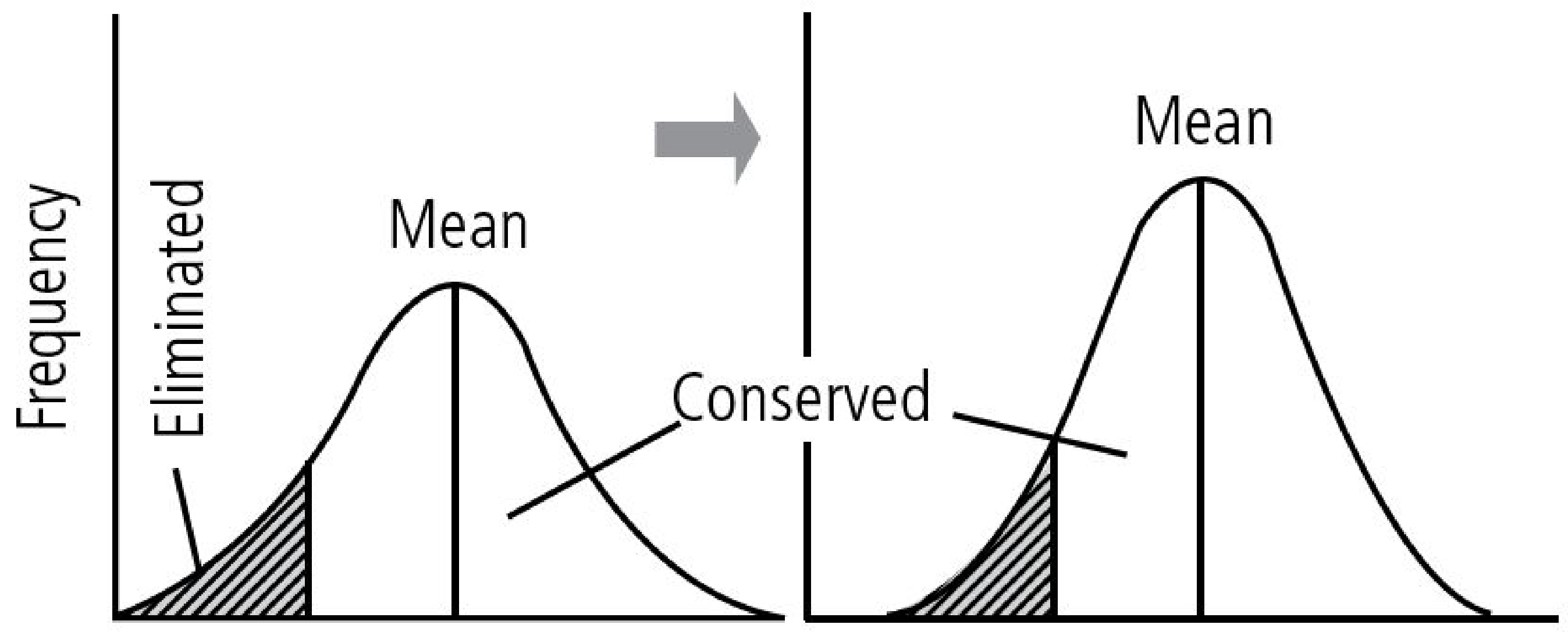
(b) The hard outer layer called the exine is made up of sporopollenin which is one of the most resistant organic material known. The inner wall of the pollen grain is called the intine. It is a thin and continuous layer made up of cellulose and pectin.

24. Hardy-Weinberg principle says that allele frequencies in population are stable and constant from generation to generation. It is affected by natural selection, as natural selection is a process by which heritable variations enabling better survival are enabled to reproduce and leave more progeny. Natural selection can lead to stabilisation (in which more individuals acquire mean character value), directional change (more individuals acquire value other than the mean character value) or disruption (more individuals acquire peripheral character value at both ends of the distribution curve).

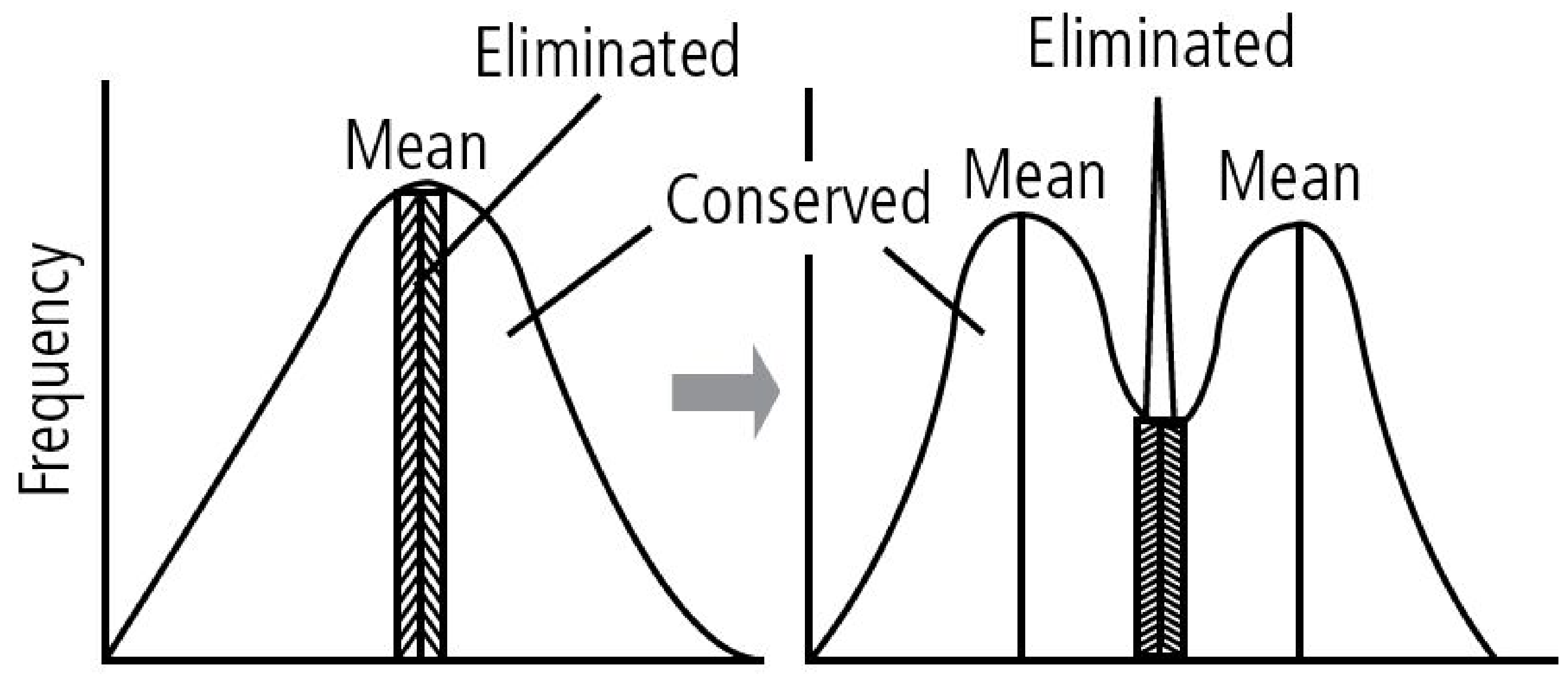
Stabilising selection or balancing selection



Directional selection or progressive selection



Disruptive selection or diversifying selection



25. A homozygous female would have the genotype AA or aa. A heterozygous male would have the genotype Aa.

Case I :

♂ ♀	A	A
A	AA	AA
a	Aa	Aa

Phenotypic ratio = 100% Dominant trait expressed

Case II :

♂ ♀	a	a
A	Aa	Aa
a	aa	aa

Phenotypic ratio = 50% Heterozygous dominant trait; 50% Recessive trait

Conclusion:

- If the female is homozygous dominant (AA), all offspring show the dominant phenotype.
- If the female is homozygous recessive(aa), then offspring show a 1:1 phenotypic ratio of dominant to recessive traits.

26. **(a)** It is necessary to conduct such tests on sportspersons because they take various drugs like cocaine/coca alkaloids and cannabinoids to increase their muscle tone and performance in sports.

(b) Cocaine/coca alkaloids and cannabinoids.

(c) Cannabinoids are obtained from *Cannabis sativa* and cocaine is obtained from *Erythroxylum* coca.

27. **(a)** The proteins encoded by the genes *cryIAb* controls corn borer.

(b) The Bt toxin protein exists as inactive protoxin but once an insect ingest the inactive toxin, it is converted into an active form of toxin due to the alkaline pH of the gut which solubilises the crystals. The activated toxin binds to the surface of midgut epithelial cells and creates pores that cause cell swelling and lysis and eventually cause death of the insect.

28. (a) X-Insects, Y-Molluscs

(b) Insects (X) are the most species-rich taxonomic group, making up more than 70 percent of the total.

(c) **(i)** Estuaries and alpine meadows in India represents ecological diversity.

(ii) The medicinal plant *Rauwolfia vomitoria* represents genetic diversity.

29. **(a)** The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood, *i.e.*, B-lymphocytes and T-lymphocytes.

(b) Antibody mediated immunity is called humoral immune response because it involves antibodies, which are found in the body fluids (humors) like blood and lymph, where they circulate and bind to antigens.

(c) **(i)** Our immune system has the ability to distinguish between self and non-self. The immune system recognises the transplanted organ as foreign agent and initiates an immune response against it, thus is responsible for graft rejection.

(ii) The cell-mediated immune response is responsible for the graft rejection. The primary cells responsible are T-lymphocytes(T-cells), particularly cytotoxic T-cells.

OR

(d) The given table shows differences between active and passive immunity:

S.No.	Active immunity	Passive immunity
(i)	It is developed when the person's own cells produce antibodies in response to infection or vaccine.	It is developed when antibodies produced in other organisms are injected into a person to counteract antigen such as snake venom.
(ii)	It is slow and takes time to give full effective response.	It is provides immediate relief.
(iii)	It has no side effects. It is long lasting.	It may cause reaction. It is not long lasting.
(iv)	*E.g.*, MMR vaccine for measles, mumps, rubella.	*E.g.*, colostrum rich in IgA antibodies provides immunity to newborn.

30. **(a)** DNA-dependent RNA polymerase is the main enzyme involved in the process of transcription.

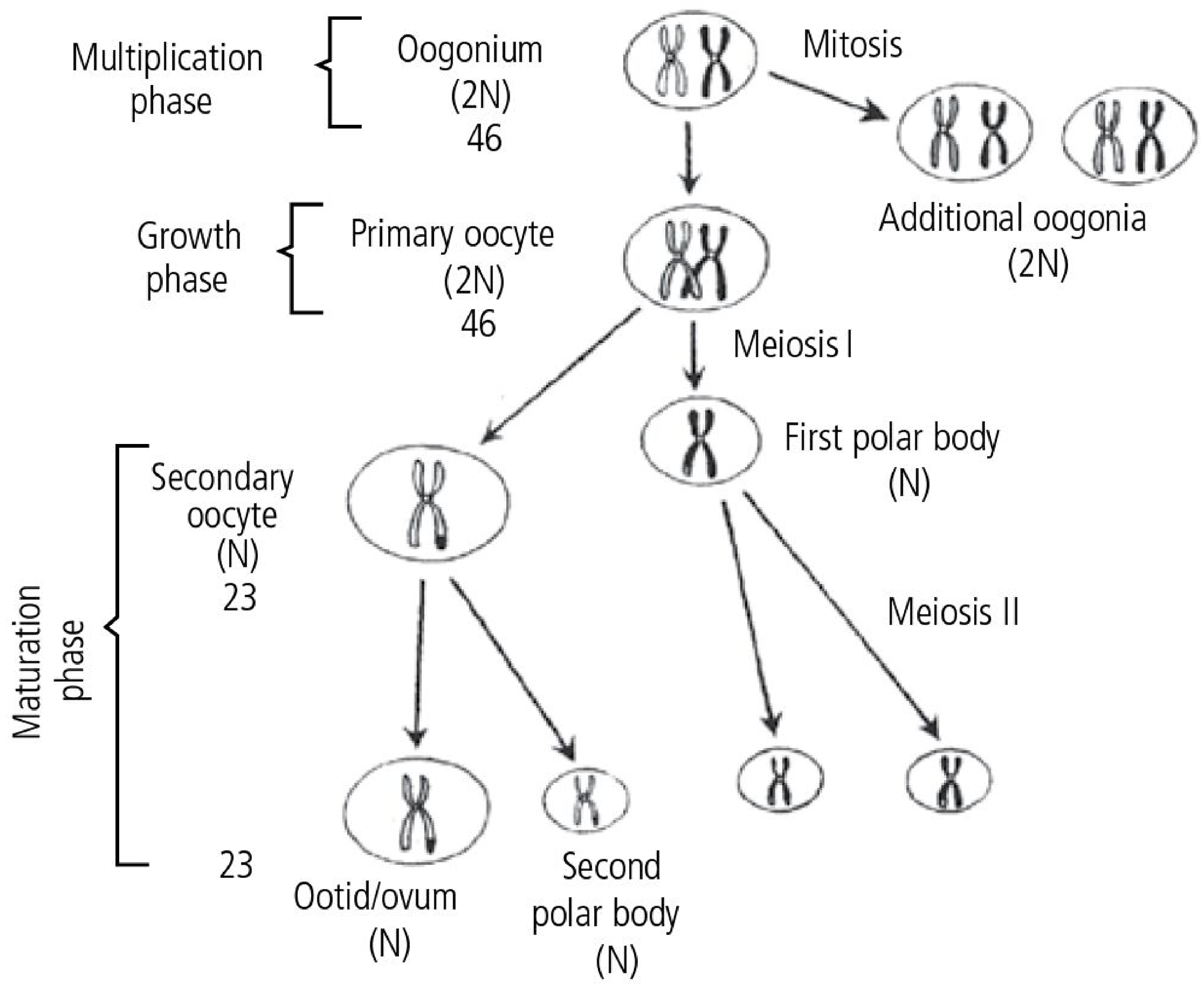
(b) In the given diagram of transcription unit, (A) is representing template strand that has 3′ → 5′ polarity and (B) is representing coding strand that has polarity 5′ → 3′.

(c) (C) is promoter and (D) is terminator. Promoter is a DNA sequence that provides binding site for RNA polymerase, and it is the presence of a promoter in a transcription unit that defines the template and coding strands. The terminator defines the end of the process of transcription.

OR

(d) In a transcription unit, promoter site (C) is located at 5′-end (upstream) of the structural gene (with respect to polarity of coding strand) while terminator site (D) is located towards 3′-end (downstream) of the coding strand.

31. (a) (i) Oogenesis is the process of formation of functional haploid ova from the diploid germinal cells in the ovary. It consists of three phases: multiplication, growth and maturation. The schematic representation of events of oogenesis is as follows:



(ii) Oogenesis is initiated during the embryonic development stage when a couple of million gamete mother cells (oogonia) are formed within each fetal ovary, no more oogonia are formed and added after birth. Oogenesis consists of three phases:

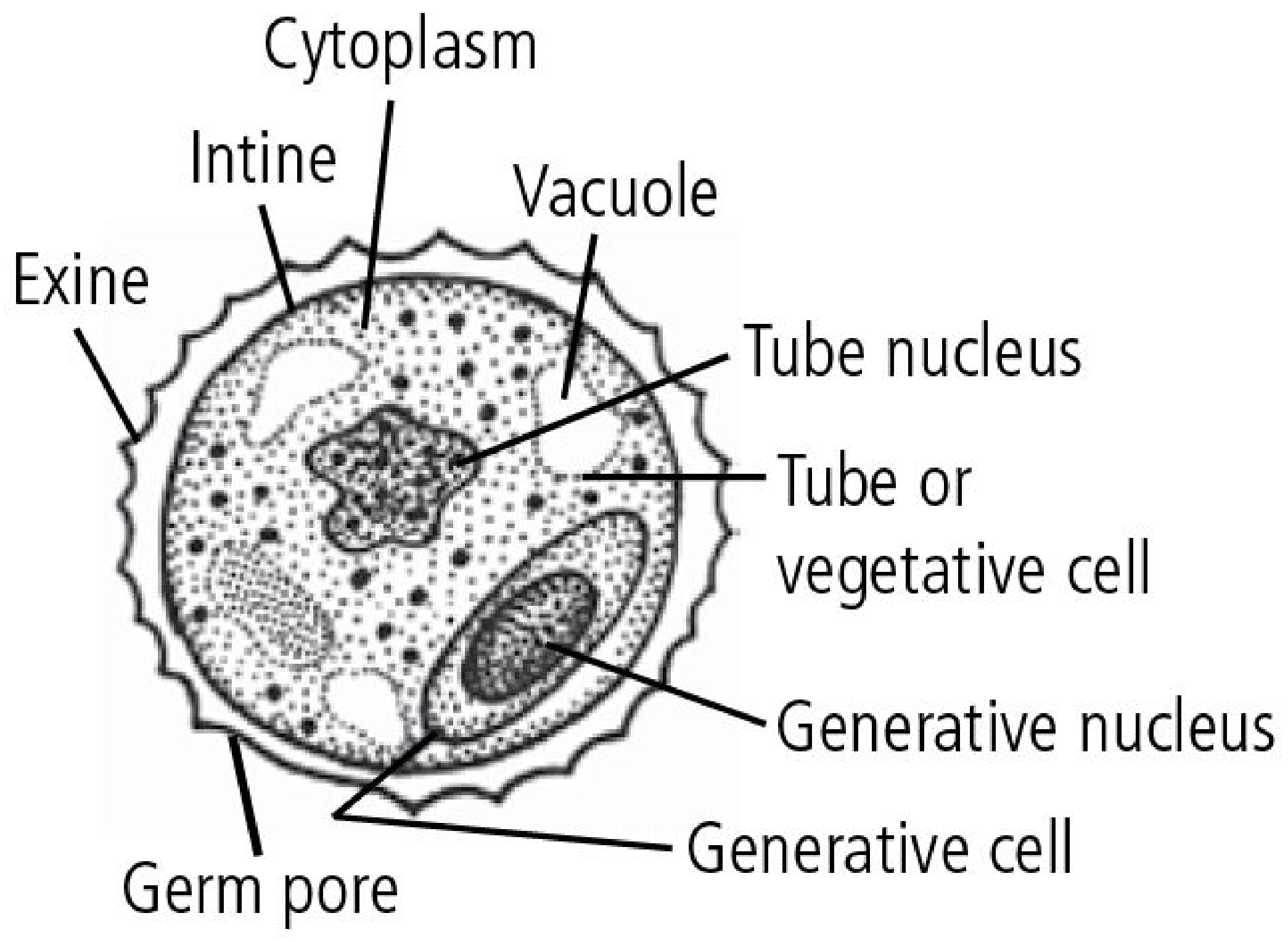
1. Multiplication phase: In the fetal development, certain cells in the germinal epithelium of the ovary of the fetus are larger than others. These cells divide by mitosis, producing a couple of million egg mother cells or oogonia. The oogonia multiply by mitotic divisions to become primary oocytes. A large number of these follicles degenerate during the phase from birth to puberty. Therefore, at puberty only 60,000 – 80,000 primary follicles are left in each ovary. Number of chromosomes present at this stage is 46.
2. Growth phase : Meiosis begins in the primary oocytes soon after their formation. However, the oocytes are arrested in the early part of meiotic prophase I. This is the first resting stage. They undergo a round of DNA synthesis, and chromosome pairing takes place. Number of chromosomes present at this stage is 46.
3. Maturation phase: After attainment of puberty, the primary follicles get surrounded by more layers of granulosa cells to form secondary follicles. Granulosa cells secrete fluid to form a cavity called antrum around the primary oocyte. The stage is called tertiary follicle. Primary oocyte grows within the tertiary follicle further and completes meiosis I. It produces a large secondary oocyte and a small polar body. The follicle grows to maximum size and is called Graafian follicle. Zona pellucida develops around secondary oocyte. The secondary oocyte proceeds with meiosis II but the division gets arrested in metaphase II stage. This is the second resting stage. It is in this stage of oocyte that the ovum is shed during ovulation. Number of chromosomes present at this stage is 23.

OR

(b) (i) A chasmogamous flower can undergo

1. Self-pollination or autogamy: It is the transfer of pollen grains from anther to the stigma of the same flower.
2. Geitonogamy: It is the transfer of pollen grains from the anther of one flower to the stigma of another flower on the same plant. Geitonogamy is functionally cross-pollination involving a pollinating agent but genetically it is equivalent to autogamy since the pollen grains come from the same plant.
3. Xenogamy or cross-pollination: It is the transfer of pollen grains from anther to the stigma of different plants of same species. It brings genetically different types of pollen grains to the stigma.

(ii) When the pollen grain is mature it majorly contains two cells, the vegetative cell and generative cell. Given below is the labelled diagram of a two-celled pollen grain.



(Label any four)

32. (a) (i) Competent host is essential for transformation with recombinant DNA. Since DNA is a hydrophilic molecule, it cannot pass through membranes, so the bacterial cells must be made capable to take up DNA, *i.e.*, made competent.

This can be achieved by:

Treatment of DNA with divalent cation, such as calcium, increases the efficiency with which DNA enters the bacterium through pores in its cell wall. Recombinant DNA (*r*DNA) can then be forced into such cells by incubating the cells with recombinant DNA on ice, followed by placing them briefly at 42°C (heat shock) and then putting them back on ice. This enables the bacteria to take up the recombinant DNA.

(ii) Polymerase chain reaction (PCR) is a technique of synthesising multiple copies (amplification) of the desired gene (DNA segment) *in vitro*. The basic requirements of PCR are DNA template, two oligonucleotide primers usually 20 nucleotides long, dNTPs and DNA polymerase which is stable at high temperature (usually *Taq* polymerase). Working mechanism of PCR is as follows:

1. Denaturation: The target DNA (DNA segment to be amplified) is heated to high temperature (94°C). Heating results in the separation of two strands of DNA. Each of the two strands of the target DNA now act as template for synthesis of new DNA strand.
2. Annealing: During this step, two oligonucleotide primers hybridise to each of single stranded template DNA in presence of excess of synthetic oligonucleotides.
3. Extension: During this step, the enzyme DNA polymerase synthesises the DNA segment between the primers. *Taq* DNA polymerase, isolated from a thermophilic bacterium *Thermus aquaticus*, is used in most of the cases. This step requires presence of deoxynucleoside triphosphates (dNTPs) and Mg^{2+} and occurs at 72°C.

OR

(b) **(i)** Animals that have had their DNA manipulated or modified to possess and express an extra (foreign) gene are known as transgenic animals. Such gene is called transgene. Examples of transgenic animals are transgenic mice, transgenic rabbit, etc.

(ii) Transgenic animals have many applications for humans. They are being used as follows:

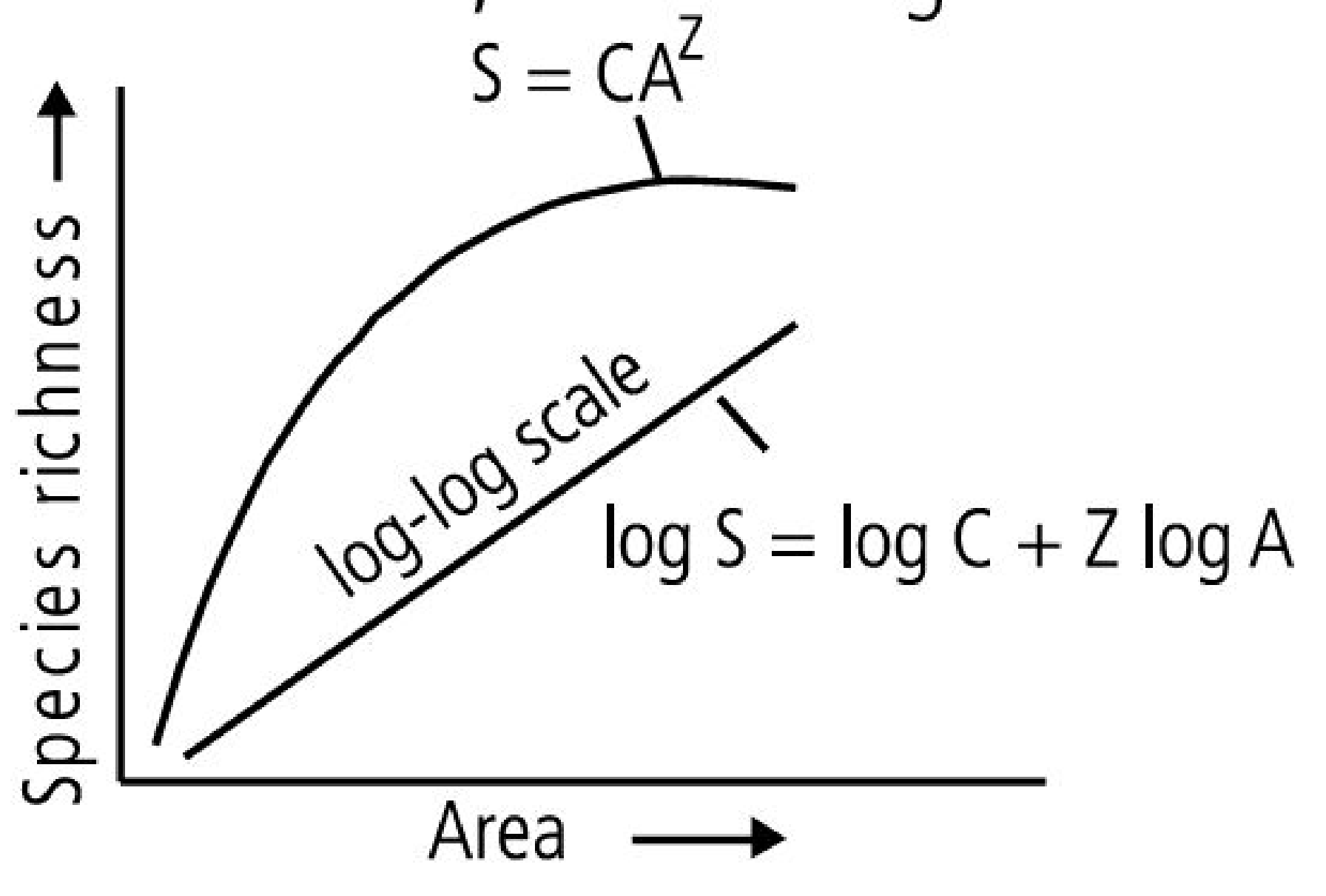
1. They are specially made to serve as models for study of human diseases, so that investigation of new treatments for diseases is made possible.
2. They produce useful biological products, that can be created by introduction of portion of gene, which codes for a particular product such as human protein (α 1- antitrypsin) used to treat emphysema.
3. Transgenic mice are being developed for use in testing the safety of vaccine before they are used in humans.
4. They are used for testing drug toxicity. Transgenic animals carry genes which make them more sensitive to toxic substances than non-transgenic animals. They are then exposed to toxic substance and the effects are studied.

33. **(a)** **(i)** Tropic have the greater species diversity because of following factors:

1. Prolonged evolutionary time: Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification.
2. Constant environment: Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialisation and lead to a greater species diversity.
3. High productivity: There is more solar energy available in the tropics, which contributes to higher productivity; this in turn might contribute indirectly to greater diversity.

(ii) German naturalist and geographer Alexander von Humboldt while exploring the wilderness of South American jungles studied species-area relationship. He observed that within a region, the species richness increased with increasing area but upto a certain limit.

The relationship between species richness and area is a rectangular hyperbola for a wide variety of taxa whether they are birds, bats, freshwater fishes or flowering plants. On a logarithmic scale, it is a straight line.



Here, S is species richness, Z is slope of line or regression coefficient, C is Y intercept while A is area.

OR

(b) **(i)** The three major causes of biodiversity loss are:

1. Habitat loss and fragmentation. Loss of habitat results in annihilation of species of endemic plants, microorganisms and forcing out of animals which in alien lands die out after some time. Migrating animals would go astray and get killed.
2. Over-exploitation–Excessive exploitation of a species, whether a plant or an animal, reduces size of its population so, that it becomes vulnerable to extinction. Due to over-exploitation by humans, Dodo, three subspecies of tiger and Steller's Sea cow have become extinct in the last 500 years.
3. Co-extinction – When a species become extinct, the plant and animal species associated with it in an obligatory way also become extinct.

(ii) *Ex situ* conservation is conservation of threatened plants and animals in places outside their natural homes under full protection and supervision. Examples: gene banks, botanical gardens, zoological parks, cryopreservation, etc.

Two examples are: tissue culture and cryopreservation.

1. Tissue culture is carried out through callus formation, embryoids, pollen grain culture and shoot tip culture for those plants which are either seedless, variable seed progeny or where clone is to be maintained.
2. Cryopreservation is *ex situ* conservation technique in which tissues, organs, embryos, seeds etc. are stored at very low temperature of –196°C. At this temperature, the living material can be stored indefinitely in compact, low maintenance refrigeration units. It can be revived as and when required. In order to prevent extinction, endangered organisms are being cryopreserved so that they can be revived to help in conservation. ☺☺

Class XI

BIO Digest

This article covers high yield facts of the given topic.

Plant Kingdom

- The Kingdom Plantae includes eukaryotic, photosynthetic organisms. According to traditional system of classification, the Kingdom Plantae is divided into two subkingdoms.

Kingdom Plantae

Cryptogamae

- Plants called cryptogams do not bear conspicuous reproductive structures like seeds *i.e.*, seedless plants.
- Plant body is not well organised and do not bear flowers, fruits and seeds.
- The reproductive structures or sex organs are invisible.

Thallophyta

- Plant body is undifferentiated and is known as thallus.
- It may range from microscopic unicellular to macroscopic multicellular forms.
- The plants are non-vascular and chlorophyllous. It includes only algae.

Bryophyta

- Represent group of plants growing in amphibious habitat.
- They are simpler and smaller embryophytes.

Pteridophyta

- Referred as first land plants or vascular cryptogams as they possess xylem and phloem.

Phanerogamae

- Phanerogams are flowering or seed plants.
- The plant body is differentiated into root, stem and leaves.
- They bear visible reproductive structures like cones and flowers.
- These are vascular plants.

Gymnospermae

- Naked seed bearing plants.
- Heterosporous
- *E.g.*, *Pinus*, *Cycas*

Angiospermae

- Plants bear covered seeds and fruits. Most evolved group of plant kingdom.
- *E.g.*, *Wolffia*, *Eucalyptus*

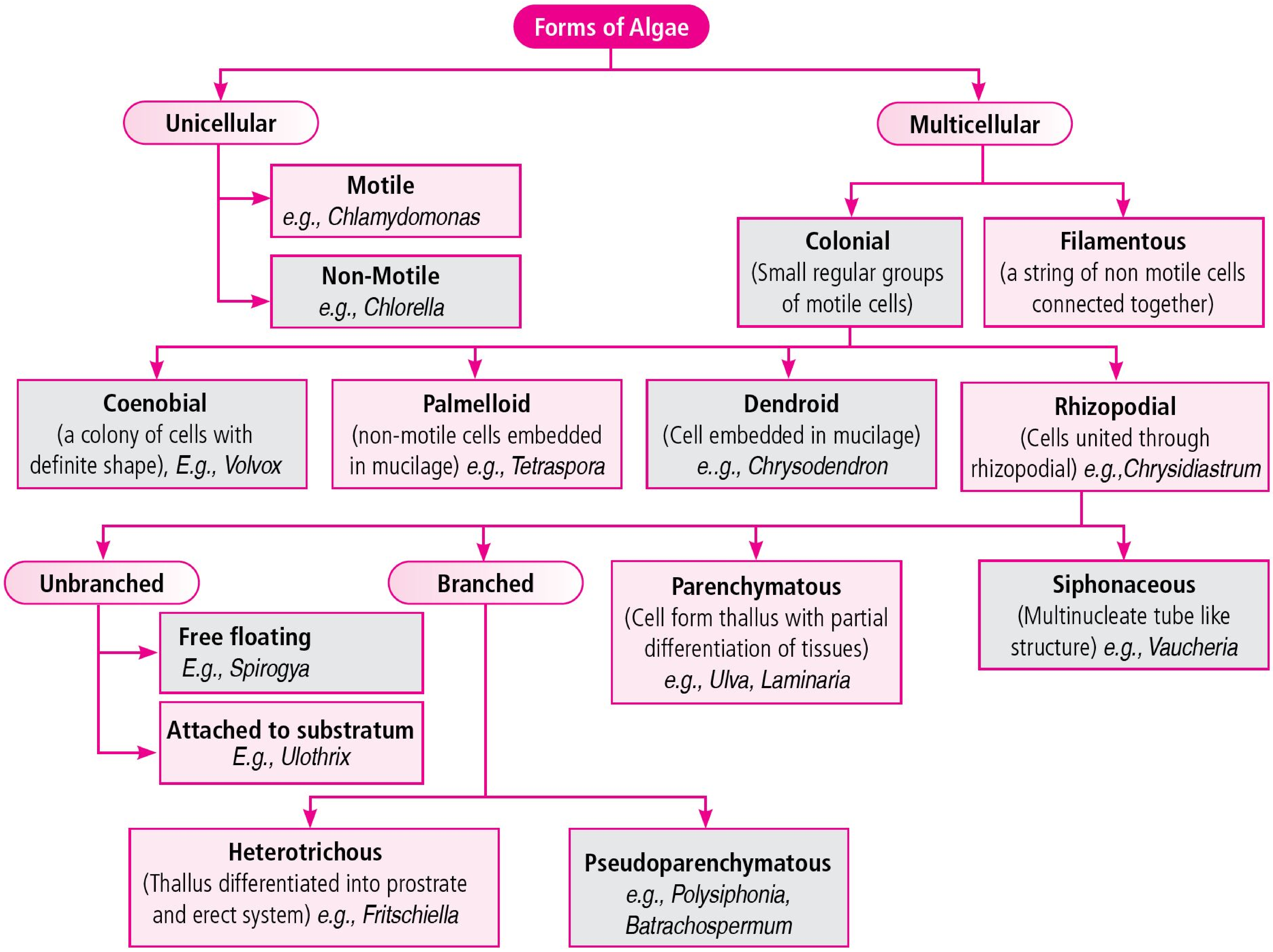
ALGAE

– Alage includes all chlorophyllous thallophytes. They include autotrophic avascular plants with thallose plant body that fail to show any cellular differentiation.

General Characteristics

– **Habitat :** Algae are distributed widely from depth of oceans to highest peak of mountains. But they are usually aquatic *i.e.*, either marine or freshwater, while only few algae occur in moist terrestrial habitats *e.g.*, tree trunks, wet rocks, moist soil.

– **Forms :** Algae may be unicellular or multicellular, ranging from small colonial (*Volvox*) to several hundred feet long (*Macrocystis*). Filamentous forms may be branched or unbranched.


Forms of Algae
Unicellular
Motile
e.g., Chlamydomonas
Non-Motile
e.g., Chlorella
Multicellular
Colonial
(Small regular groups of motile cells)
Filamentous
(a string of non motile cells connected together)
Coenobial
(a colony of cells with definite shape), E.g., Volvox
Palmelloid
(non-motile cells embedded in mucilage) e.g., Tetraspora
Dendroid
(Cell embedded in mucilage) e..g., Chrysodendron
Rhizopodial
(Cells united through rhizopodial) e.g.,Chrysidiastrum
Unbranched
Free floating
E.g., Spirogya
Attached to substratum
E.g., Ulothrix
Branched
Heterotrichous
(Thallus differentiated into prostrate and erect system) e.g., Fritschiella
Pseudoparenchymatous
e.g., Polysiphonia, Batrachospermum
Parenchymatous
(Cell form thallus with partial differentiation of tissues) e.g., Ulva, Laminaria
Siphonaceous
(Multinucleate tube like structure) e.g., Vaucheria

- The plant body is covered by mucilage which protects the algae from epiphytic growth and decaying effect of water.
- Vascular and mechanical tissues are absent, therefore the body is flexible and easily gets swayed without being torn.
- Nutrition is photosynthetic. Grana are absent in chloroplast. The chloroplast varies in appearance among different algal forms, *e.g.*, cup shaped, girdle shaped, reticulate or ribbon shaped.
- Algae contain chlorophyll *a*, *b*, *c*, *d*, carotenes and xanthophylls. Additional pigments like phycobilins, fucoxanthin occur in specific groups.
- Pyrenoids are associated with chloroplast for storage of starch. The reserve food may be starch, laminarin, mannitol, oil, fats etc. which differs among different algal members.
- Vegetative and asexual modes of reproduction are present.
  - Vegetative reproduction may take place by fragmentation (*e.g.*, *Ulothrix*, *Oedogonium*), fission (*e.g.*,*Chalmydomonas*), hormogonia (*e.g.*, *Oscillatoria*), tubers (*e.g.*, *Chara*), budding (*e.g.*, *Protosiphionia*), etc.
  - Asexual reproduction takes place by flagellated **zoospores** (*e.g.*, *Ulothrix*, *Oedogonium*); non-motile, thin walled **aplanospore** (*e.g.*, *Chlorella*, *Microspora*) and non-motile, thick walled hypnospores (*e.g.*, *Vaucheria*,

WHO AM I ...

"I am a class of algae that has laminarian and mannitol as reserve food material."

...search me ☺

Chlamydomonas nivalis, thick walled akinetes (*e.g.*, *Cladophora*), palmella stage (*e.g.*, *Chlamydomonas*).

- Under favourable conditions, algae show sexual reproduction which may be isogamous or heterogamous (*i.e.*, anisogamous and oogamous). Sex organs are non-jacketed and one celled called gametangia.
- Life cycle may be haplontic, diplontic or diplohaplontic.

Classification

- Dr. F.E. Fritsch, known as father of algae, classified algae into various classes depending upon the phylogeny, affinities and inter-relationship.
- However, according to Whittaker's system of classification, algae are mainly of three types : Green, brown and red.

Table: Characteristics of different classes of algae

Classes	Structure	Occurrence	Major pigments	Reserve food material	Reproduction		
					Vegetative	Asexual	Sexual
Chlorophyceae, (Green algae) *e.g.*, *Spirogyra*, *Ulothrix*	Unicellular to heterotrichous filaments. Cellulosic cell wall. Starch sheathed pyrenoids. Motile cells with 2-4 equal flagella.	Mostly fresh water a few marine. A marked tendency towards terrestrial habitat.	Chl. *a* and *b*, carotenes and xanthophyll	True starch and sugar	Fragmentation or fission	Zoospores	Isogamous to advanced oogamous
Phaeophyceae (Brown algae) *e.g.*, *Fucus*, *Sargassum*	Simple filamentous to bulky parenchymatous with giant size, external and internal differentiation, motile cells with 2 lateral flagella.	Mostly marine	Fucoxanthin, flavoxanthin, β-carotenes, Chl. *a* and *c*.	Laminarin, mannitol	Fragmentation is most common.	Zoospores, tetraspores etc.	Isogamous to oogamous
Rhodophyceae (Red algae) *e.g.*, *Polysiphonia*, *Porphyra*	Simple filamentous to complex forms. Motile cells not known.	Few freshwater, others are marine.	Phycoerythrins, phycocyanin, allophycocyanin, carotenoids, Chl. *a* and *d*.	Floridean starch	Uncommon, except unicellular ones	Monospores, carpospores, polyspores etc.	Advanced oogamous type producing special carpospores.

Economic Importance

Food

Sea weeds and certain marine algae are used as food *e.g.*, *Porphyra*, *Laminaria*, *Sargassum* etc., *Chlorella* and *Spirulina* are rich sources of proteins, hence used as food supplements.

Photosynthesis

Nearly 50% of total photosynthesis on earth is carried out by algae. It is essential for respiration of aquatic life.

Alginic acid

Obtained from Phaeophyceae such as *Laminaria*, *Macrocystis*, *Fucus*, etc. It is used in stabilising emulsions, flameproof plastics, security glass and artificial fibres.

Agar-agar

A phycocolloid extracted from species of red algae as *Gelidium*, *Gracilaria* and *Gigartina* is used as a solidifying agent in culture medium, canning of fish and meat, sizing of textiles and paper etc.

Carrageenan

Obtained from red algae *Chondrus crispus* and issued as pharmaceutical emulsifier, cleaning agent and in textile, leather and brewing industries.

Medicines

Owing to high iodine content, brown algae are used in various goitre medicines.

Sewage disposal

Green algae like *Chlamydomonas*, *Chlorella*, *Scendesmus* are components of sewage oxidation tanks which provide aerobic conditions for disposal of sewage by decomposers.

- **Algal pollution :** Algae is also known to cause pollution, called as algal bloom. It affect water supply and purification and become obnoxious in water reservoirs, rivers and oceans.

INTEXT PRACTICE QUESTIONS

1. **Name the group of algae in which plant body is differentiated into holdfast, stipe and frond.**
2. **Which pigment is responsible for brown colour of phaeophyceae?**

BRYOPHYTES

- Bryophytes are simplest and most primitive non vascular terrestrial plants of moist habitats in which a multicellular diploid sporophyte lives as parasite on an independent multicellular haploid gametophyte.
- They are able to live on land as well as in water, therefore are called as "amphibians of plant kingdom."

General Characteristics

- **Habitat :** Bryophytes live in damp and shady habitats, usually found in rainy season forming green carpets or mats on damp soil, rocks, walls, tree trunks etc.
- The dominant phase of the plant is a free living gametophyte.
- Rhizoids (instead of roots) are present. They may be unicellular or multicellular.

Bryophytes seldom attain great heights and thus remains small in size. It may be due to
- absence of roots and vascular tissues
- absence of cuticle on plant body
- absence of mechanical tissues
- requirement of external sheet of water for capillary conduction.

- **Reproduction :** Vegetative reproduction is quite common. It may take place by fragmentation, tubers, gemmae *e.g.*, *Marchantia*, buds, adventitious branches *e.g.*, *Riccia*.
- Accessory spores are not formed.
- Sexual reproduction is oogamous *i.e.*, fusion of a non-motile passive egg cell and biflagellated active male gamete.
- Sex organs are multicellular and jacketed and are of two types : **antheridium** (male), and **archegonium** (female).
- Antheridium produces a number of flagellated male gametes called sperms or antherozoids.
- Archegonium is flask shaped with tubular single layered neck (having 5-6 rows of cells) and a swollen venter (1-2 layered wall) enclosing a sterile ventral canal cell and a fertile egg.
- The sterile neck canal cells and venter canal cells of archegonium degenerate, gelatinise, absorbs water and swells up into mucilage. It opens the lid of neck and leads a passage upto oosphere.
- An external layer of water is essential for the swimming of male gametes to archegonia.
- Fertilisation leads to formation of embryo inside archegonium. The embryo grows into a sporophyte, which is parasitic on gametophyte. Since it is dependent on gametophyte, it is called **sporogonium**.
- Sporophyte consists of foot, seta and capsule. In some members, however, the sporophyte is represented either only by capsule (*e.g.*, *Riccia*) or by foot and capsule (*e.g.*, *Corrinia*).
- Sporogonium produces haploid meiospores inside its capsule. On germination, each spore produces a gametophyte either directly or through a juvenile stage called **protonema**.
- Bryophytes show heteromorphic or heterologous alternation of generations.

Classification

Table: Classification of bryophytes

Features	Hepaticopsida	Anthocerotopsida	Bryopsida
Common name	Liverworts	Hornworts	Mosses
Gametophytic plant body	May be thallose or foliose. Aseptate rhizoids.	Thallose Aseptate rhizoids	Gametophyte has two growth stages: thalloid protonema stage and leafy gametophore stage. Obliquely septate rhizoids.
Sex organs	Present on dorsal surface of thallus.	Present on dorsal surface of thallus.	Develop from the superficial cells at the apex of leafy gametophore.
Sporophyte or sporogonium	Simple, represented by capsule only *e.g.*, *Riccia* or differentiated into foot, seta and capsule (*e.g.*, *Marchantia*).	Differentiated into a bulbous foot, small meristematic seta and long cylindrical capsule.	Differentiated into foot, seta and capsule.

Elaters	Generally present, absent in some like *Riccia.*	Pseudoelaters are present in the capsule.	Absent
Sporogenous cells	Develops from endothecium.	Develops from amphithecium and endothecium, forms sterile columella.	Develops from outer layer of endothecium. Inner layer forms sterile columella.
Dehiscence of capsule	Irregular and indefinite	Irregular	Regular
Examples	*Riccia, Marchantia, Sphaerocarpos,* etc.	*Anthoceros, Notothylas, Megaceros,* etc.	*Sphagnum, Polytrichum, Funaria,* etc.

Liverworts

- The liverworts grow usually in moist, shady habitats such as banks of streams, marshy ground, damp soil, bark of trees and deep in the woods. The plant body of a liverwort is thalloid, *e.g.*, Marchantia. The thallus is dorsiventral and closely appressed to the substrate.
- Asexual reproduction in liverworts takes place by fragmentation of thalli, or by the formation of specialised structures called gemmae (sing. gemma). Gemmae are green, multicellular, asexual buds, which develop in small receptacles called gemma cups located on the thalli.
- The gemmae become detached from the parent body and germinate to form new individuals. During sexual reproduction, male and female sex organs are produced either on the same or on different thalli. The sporophyte is differentiated into a foot, seta and capsule. After meiosis, spores are produced within the capsule. These spores germinate to form free-living gametophytes.

Mosses

- The predominant stage of the life cycle of a moss is the gametophyte which consists of two stages. The first stage is the protonema stage, which develops directly from a spore. It is a creeping, green, branched and frequently filamentous stage.
- The second stage is the leafy stage, which develops from the secondary protonema as a lateral bud. They consist of upright, slender axes bearing spirally arranged leaves. They are attached to the soil through multicellular and branched rhizoids. This stage bears the sex organs.
- Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema. In sexual reproduction, the sex organs antheridia and archegonia are produced at the apex of the leafy shoots. After fertilisation, the zygote develops into a sporophyte, consisting of a foot, seta and capsule. The sporophyte in mosses is more elaborate than that in liverworts. The capsule contains spores. Spores are formed after meiosis. The mosses have an elaborate mechanism of spore dispersal. Common examples of mosses are Funaria, Polytrichum and Sphagnum.

Economic Importance

Prevention of soil erosion

Mosses form dense mats over the soil and prevent soil erosion by running water.

Soil formation

They make an important link in ecological succession on rocky areas by taking part in soil formation in rocky crevices, formed by lichens. For example, growth of *Sphagnum* fills ponds and lakes with soil.

Water retention

Some bryophytes or mosses as *Sphagnum* can retain or absorb 18-26 times its weight of water. This water retention capability is employed by gardeners to keep seedlings and cut plants moist during transportation and propagation.

Peat

Sphagnum often grows in acidic marshes where there is little decay. The dead parts of moss and other marshy plants slowly get carbonised, compressed and fossilised over thousands of years to produce a dark spongy mass called peat. It is dried, compressed and cut to form blocks. Peat is used as good manure to overcome soil alkalinity and it increases water retention as well as aeration.

Affinities of Bryophytes with Algae

I. Resemblances of bryophytes with algae

(i) Presence of thalloid and gametophytic plant body.
(ii) Autotrophic nature of plants.
(iii) In both groups, chloroplasts contain chlorophyll-*a*, *b*, α-and β-carotene, lutein, violaxanthin and xeoxanthin.
(iv) Starch as reserve food material.
(v) Dominance of gametophyte.
(vi) Absence of vascular tissues.
(vii) Absence of true roots, stem and leaves.
(viii) Dependence on water for fertilisation.

II. Table: Differences between algae and bryophytes

	Algae	Bryophytes
(i)	Most of the algae are aquatic.	These are terrestrial plants occurring mostly in shady and moist habitats.
(ii)	Plant body is unicellular, multicellular, filamentous or pseudoparenchymatous.	Plant body is multicellular, parenchymatous and thalloid or differentiated into rhizoids, axis and lateral appendages.
(iii)	Filaments are unbranched or show regular or irregular branching.	Thallus is usually dichotomously branched.
(iv)	Plant body does not show division of labour.	Although plant body does not show distinct division of labour, cells in different parts have specific functions.
(v)	Structures like pores and stomata are absent.	Pores and stomata are present.
(vi)	Asexual reproduction is common and it takes place by zoospores, aplanospores or akinetes.	Asexual reproduction is absent but some species multiply by vegetative means.
(vii)	Sexual reproduction is isogamous, anisogamous or oogamous.	Sexual reproduction is oogamous.
(viii)	Sex organs are usually unicellular and do not have a covering of sterile cells.	Sex organs are multicellular and have a protective covering (jacket) of sterile cells.
(ix)	Zygote usually undergoes a period of rest after liberation from the parent plant.	Zygote divides immediately after fertilisation to form sporophytes.
(x)	Zygote does not form embryo, instead haploid spores are formed.	Zygote forms embryo.

INTEXT PRACTICE QUESTIONS

3. Mention the name of male and females sex organs of bryophytes.

4. State the economic importance of *Sphagnum*.

PTERIDOPHYTES

- Pteridophytes are seedless vascular plants *i.e.*, cryptogams having sporophyte plant body and inconspicuous gametopyte. They are called as “Botanical snakes’’ evolved after amphibians (bryophytes).

General Characteristics

- **Habitat :** They grow in a variety of habitats but mostly they are terrestrial plants that thrive well in abundant moisture and shade while some flourish well in xeric conditions.
- The sporophytic plant body is differentiated into true roots, stem and leaves, though some of the primitive members may lack true roots and well developed leaves.
- Leaves can be **microphyllous** *i.e.*, small without forming leaf gaps in vascular supply or **macrophyllous** *i.e.*, large forming leaf gaps *e.g.*, ferns.
- The branching of the stem may be dichotomous type or monopodial.
- Pteridophytes show presence of vascular tissues; xylem and phloem. In xylem, true vessels are absent while, in phloem, companion cells and sieve tubes are absent.
- The vascular system of pteridophytes varies in different groups showing stelar system ranging from simple protostele, siphonostele or a dictyostele.
- The sporophytes reproduces asexually by means of spores, produced in small capsules called sporangia. Leaves bearing sporangia are called **sporophylls** which may be widely scattered or clustered in definite areas and structures called cones or **strobili**.
- The diploid spore mother cells or **sporocytes** within the sporangia undergo meiosis or reduction division to form spores. These spores may be similar as in majority of pteridophytes called **homosporous** *e.g.*, *Lycopodium* and *Dryopteris* or different with two types of spores (microspores and megaspores) called **heterosporous** *e.g.*, *Selaginella*, *Salvinia*.
- Spores upon germination give rise to haploid gametophytes or prothallus bearing multicellular, jacketed sex organs.

- Gametophytes formed from homospores are monoecious (both antheridia and archegonia are borne on same prothallus) while those formed from heterospores are dioecious (antheridia and archegonia develop on separate male and female prothallus).
- Antheridia are small and sessile comprising of androcytes, each of which produces a motile antherozoid. Archegonia are partially embedded and consists of 4-rowed neck.
- Water is essential for fertilisation, as it assists in carrying bi-or multiflagellate sperms to archegonia.
- The young sporophyte is dependent on gametophyte during its early years.
- Pteridophytes exhibit alternate succession of sporophytic and gametophytic generation.

- Evolution of Seed Habit. The ability of plant to form seed is called seed habit. It is considered to have originated in pteridosperms during Devonian-carboniferous periods. The development of zygote into young embryo within female gametophyte in heterosporous plants *e.g.*, *Selaginella* is a precursor to the evolution of seed habit.
- The differentiation of spores into microspores and megaspores and their dependence on the parent sporophyte for the nutrition are certain features considered as pre-requisites for the formation of seeds.

Classification of Pteridophytes

Pteridophyta

Psilophyta
- These are **oldest known land inhabiting plants**.
- Rootless, rhizoids are present.
- **Homosporous**
- Most plants are fossils, *e.g., Rhynia, Horneophyton* etc.

Lycophyta
- Commonly called **club mosses** or **spike mosses**.
- Roots, stem and leaves are present.
- Members are microphyllous.
- **Homosporous** (*Lycopodium*) or **heterosporous** (*Selaginella*).

Sphenophyta
- At nodes, whorls of small leaves are present.
- Deposition of silica in stems make them rough in touch.
- Ridges and grooves are found in stem.
- Always **homosporous**, *e.g., Equisetum*.

Pterophyta/Filicophyta
- Fan like leaves.
- Stem is in the form of rhizome.
- May be **homosporous** (*Dryopteris*, *Pteris*) or **heterosporous** (*Marsilea*).

Economic Importance

Food

Pteridophytes constitute a good source of food to animals. Sporocarps of *Marsilea* are cooked and eaten by certain tribals.

Binding of soil

Pteridophytes bind the soil even along hill slops, thus preventing soil erosion.

Scouring

Stems of some plants are used in scouring or cleaning of utensils and polishing of metals *e.g., Equisetum*.

Nitrogen fixation

Some ferns *e.g.,* water fern *Azolla* form symbiotic association with nitrogen fixing cyanobacterium *Anabaena azollae*. These are used as biofertilisers in paddy fields.

Medicines

Rhizomes of male shield fern are used to obtain anti-helminthic drug. *Equisetum* is used in preparation of diuretic, haemostatic and haemopoietic drugs.

Ornamental

Ferns are known for their attractive foliage, hence are grown as ornamental plants and used in bouquets and floral decorations.

Affinities of Pteridophytes with Bryophytes

I. Resemblances of pteridophytes with bryophytes

(i) Identical jacketed sex organs.

(ii) Flagellated male gametes.

(iii) Fertilisation in film of water.

(iv) Fundamentally similar structure of archegonium.

(v) Both show heteromorphic alternation of generation.

(vi) The sexual reproduction in both groups is oogamous; the male and female reproductive structures are known as antheridia and archegonia respectively.

(vii) Zygote forms embryo.

(viii) The terminal sporangia with columella of Psilophytales are similar to moss capsules.

(ix) Many pteridophytes are homosporous (*e.g., Lycopodium, Equisetum, Psilotum, Polypodium*, etc.) like bryophytes.

II. Differences between pteridophytes and bryophytes

(i) The most striking characteristic which distinguishes pteridophytes from bryophytes is that the plant body in the former is sporophytic and in the latter gametophytic.

(ii) The plant body of pteridophytes is differentiated into root, stem and leaves, whereas in bryophytes it is thalloid or foliose.

(iii) The vascular system of pteridophytes is well developed and composed of xylem and phloem, whereas there is no vascular tissue in bryophytes.

(iv) Vegetative reproduction is more common in bryophytes than in pteridophytes.

(v) Bryophytes are always homosporous, whereas many pteridophytes show heterospory.

(vi) In pteridophytes, the sporophyte is large, long lived and independent of the gametophyte but in bryophytes, it is completely or partly dependent on the gametophyte.

(vii) The sporophyte of some bryophytes has elaters along with spores but elaters are altogether absent in pteridophytes.

INTEXT PRACTICE QUESTIONS

5. Briefly comment on significance of heterospory.

6. Write down the general characteristics of seedless vascular plants.

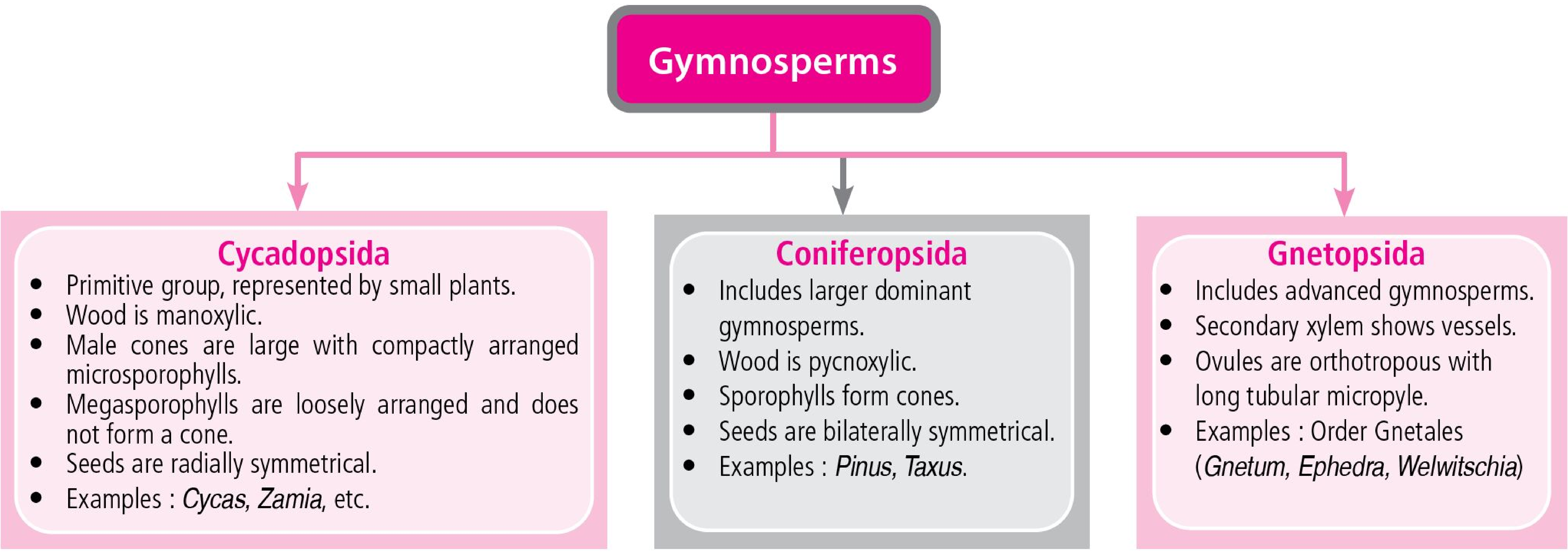
GYMNOSPERMS

- Gymnosperms are plants with naked seeds, having freely exposed ovules on megasporophylls. They are referred to as phanerogams without ovary and act as connecting link between pteridophytes and angiosperms.

General Characteristics

- Though the gymnosperms are widely distributed but they are more abundant in temperate regions.
- Sporophyte is dominant and differentiated into root, stem and leaves. Usually tap roots are present but in some cases **coralloid** roots (*e.g.*, *Cycas*) or mycorrhiza (*e.g.*, *Pinus*) is present. Stem is erect, aerial and woody. It may be branched or unbranched *e.g.*, *Cycas*.
- Leaves are dimorphic *i.e.*, foliage and scale leaves. Flowers are absent, instead sporophylls *i.e.*, microsporophylls and megasporophylls are aggregated to form distinct cones or strobili.
- Plants may be dioecious (*e.g.*, *Cycas*) or monoecious (*e.g.*, *Pinus*) and are heterosporous producing microspores and megaspores.
- Gametophytic generation is much reduced. The pollen grain forms the first male gametophyte while the female gametophytic cells is represented by functional megaspore that produces nuclear and later cellular female gametophyte (archegonia).
- Pollination takes place by wind and pollen grains directly reach the ovules. The male gametes reaches the female gamete by forming a tube *i.e.*, **Siphonogamy**, to effect fertilisation.
- Endosperm is gametophytic and derived from female gametophyte. Polyembryony is common in *Pinus*. The number of cotyledons may be one or two or a whorl of many.
- Fruits are not formed due to absence of ovary.
- Xylem do not possess vessels (except in Gnetales) and phloem do not possess companion cells and sieve tubes.
- Vascular bundles are open in stem, thus show secondary growth.

Classification of Gymnosperms



Gymnosperms

Cycadopsida
- Primitive group, represented by small plants.
- Wood is manoxylic.
- Male cones are large with compactly arranged microsporophylls.
- Megasporophylls are loosely arranged and does not form a cone.
- Seeds are radially symmetrical.
- Examples : *Cycas*, *Zamia*, etc.

Coniferopsida
- Includes larger dominant gymnosperms.
- Wood is pycnoxylic.
- Sporophylls form cones.
- Seeds are bilaterally symmetrical.
- Examples : *Pinus*, *Taxus*.

Gnetopsida
- Includes advanced gymnosperms.
- Secondary xylem shows vessels.
- Ovules are orthotropous with long tubular micropyle.
- Examples : Order Gnetales (*Gnetum*, *Ephedra*, *Welwitschia*)

Economic Importance

Food
Seeds of *Pinus gerardiana* are edible and are eaten after roasting.

Timber
The softwood of gymnosperms is used in preparation of light furniture, plywood, packing cases etc.

Paper
A wide range of gymnosperms are utilised in manufacture of paper *e.g.*, *Picea*, *Pinus*, *Abies* etc.

Resin
It is a semifluid secretion containing terpenes, resin, acids and esters which solidifies on exposure to air. It helps in sealing, is antiseptic and toxic to pests, thus, prevents microbial and insect attack. Resin is commercially extracted to obtain turpentine and resin.

Ephedrine
It is a drug obtained from *Ephedra* and used in curing respiratory ailment, including asthma.

Affinities of Gymnosperms with Pteridophytes

I. Resemblances of gymnosperms with pteridophytes

(i) Both these groups show distinct alternation of generations with dominant sporophytic phase.

(ii) Sporophytic plant body is differentiated into root, stem and leaves.

(iii) The leaves of gymnosperms show circinate vernation like those of ferns. They are pinnately composed in the groups.

(iv) Xylem in pteridophytes as well as gymnosperms lacks vessels except for Gnetales. Phloem is devoid of companion cells.

(v) Several fossils and living pteridophytes show secondary growth like gymnosperms.

(vi) In some gymnosperms like *Cycas*, sporangia occur in groups or in sori as in ferns.

(vii) Sporangia are formed on specialised leaves, known as sporophylls. As in most pteridophytes, mega- and microsporophylls also form compact strobili in gymnosperms.

(viii) In some pteridophytes, suspensor is also formed during embryo development as in gymnosperms.

II. Differences between gymnosperms and pteridophytes

(i) Gymnosperms are mostly trees, whereas pteridophytes are usually perennial herbs or shrubs.

(ii) Pteridophytes usually grow in moist, shady and terrestrial places, while gymnosperms occur in xerophytic habitats.

(iii) Pteridophytes possess adventitious roots, whereas gymnosperms have tap roots.

(iv) Pteridophytes lack vascular cambium (hence do not show secondary growth), while cambium is present in gymnosperms (hence they show secondary growth).

(v) Gymnosperms have ovule and seeds but these structures are absent in pteridophytes.

(vi) The gametophytes of gymnosperms are fully dependent on sporophyte, whereas those of pteridophytes are green, autotrophic and independent of sporophyte.

(vii) In gymnosperms, partial development of the male gametophyte occurs within the sporangium, but in pteridophytes spores germinate only after their liberation from the sporangium.

(viii) Pollen tube is the sperm carrier in gymnosperms, whereas no such structure is formed in pteridophytes.

(ix) Neck canal cells are absent in gymnosperms but are present in pteridophytes.

INTEXT PRACTICE QUESTIONS

7. "Gymnosperms are referred as naked seeded plants." Justify the statement.

8. Give some medicinal uses of Gymnosperms.

ANGIOSPERMS

- Angiosperms are seed plants in which sporophylls are organised into flowers and seeds are produced inside fruits. They are the most highly evolved plants and form the dominant vegetation of present day earth.

General Characteristics

- Angiosperms or flowering plants occur in most environments on the earth.
- Plant body is sporophytic and represented by herbs, shrubs, trees, twiners, trailers, climbers, etc.

- Sporophyte is differentiated into roots, stem and leaves.
- Xylem possess vessels while phloem possess sieve tubes and companion cells. Vascular bundles are conjoint and collateral and open in dicots, hence show secondary growth.
- Sporophylls are aggregated to form flowers. Both microsporophylls and megasporophylls are specialised to form stamen and carpel producing male and female gametes respectively.
- Archegonia is absent and female gametophyte is represented by embryo sac.
- Pollination takes place by several agencies.
- Double fertilisation is characteristic feature of angiosperms, wherein of two male gametes, one fuses with egg to form zygote while other fused with central cell to form PEN (Primary endosperm nucleus).
- Endosperm is triploid, formed after fertilisation and represents a new structure.
- The ovary develops into fruit and ovules ripen into seeds, after fertilisation. This is another peculiar feature of angiosperms.

Angiosperms have developed **xylem vessels** that are absent in all other vascular plants. Vessels are efficient conductors. Besides, flower ensure pollination and fruits ensure seed dispersal more effectively. That is why they make the dominant vegetation on earth.

WHO AM I ...

"I do not have roots and am present in damp and shady habitats."

...search me ☺

Classification of Angiosperms

- Angiosperms are divided into two classes:

Table: Comparison between dicots and monocots

Features	Dicots	Monocots
Cotyledons	Usually two	One cotyledon
Flowers	Penta or tetramerous	Trimerous
Pollen grains	Three germ pores	Single germinal furrow
Venation	Reticulate	Parallel except a few
Primary root	Often long lived forming tap root system. Adventitious roots occur in some.	Short-lived, Tap roots absent, instead adventitious roots are found.
Vascular bundles of stem	In a ring, cambium (open), thus secondary growth present.	Scattered, cambium is absent (closed).
Root	Pith absent or small. Vascular bundles 8 or less.	Pith present. Vascular bundles more than 8.
Xylem vessels	Polygonal	Rounded

Affinities of Gymnosperms with Angiosperms

I. Resemblances of gymnosperms and angiosperms

(i) Sporophyte is differentiated into root, stem and leaves.

(ii) The vascular system of stem consists of conjoint, collateral and open vascular bundles.

(iii) The stem increases in girth by secondary growth.

(iv) Vessels and companion cells also occur in some gymnosperms (Gnetales) like angiosperms.

(v) Like gymnosperms, many angiosperms are also wind pollinated.

(vi) Fertilisation occurs with the help of pollen tube in both groups.

(vii) Development of megaspore into female gametophyte takes place inside the megasporangium (ovule).

(viii) In both groups, ovules develop into seeds.

(ix) The seed germination is epigeal or hypogeal in both groups.

(x) The gametophytic phase is reduced in both groups.

II. Differences between gymnosperms and angiosperms

(i) Gymnosperms are mostly woody trees, but angiosperms have a variety of trees, shrubs or herbs.

(ii) Xylem vessels and companion cells are of universal occurrence in angiosperms (except for some vessel-less genera) but they are only confined to Gnetales amongst gymnosperms.

(iii) The strobili of gymnosperms are usually unisexual, whereas the flowers of angiosperms are mostly bisexual.

(iv) The ovules of gymnosperms are naked, whereas those of angiosperms remain enclosed within the ovary wall.

(v) The structures like ovary, style and stigma are not found in gymnosperms.

(vi) In the female gametophyte of gymnosperms, archegonia are present but they are not found in angiosperms.

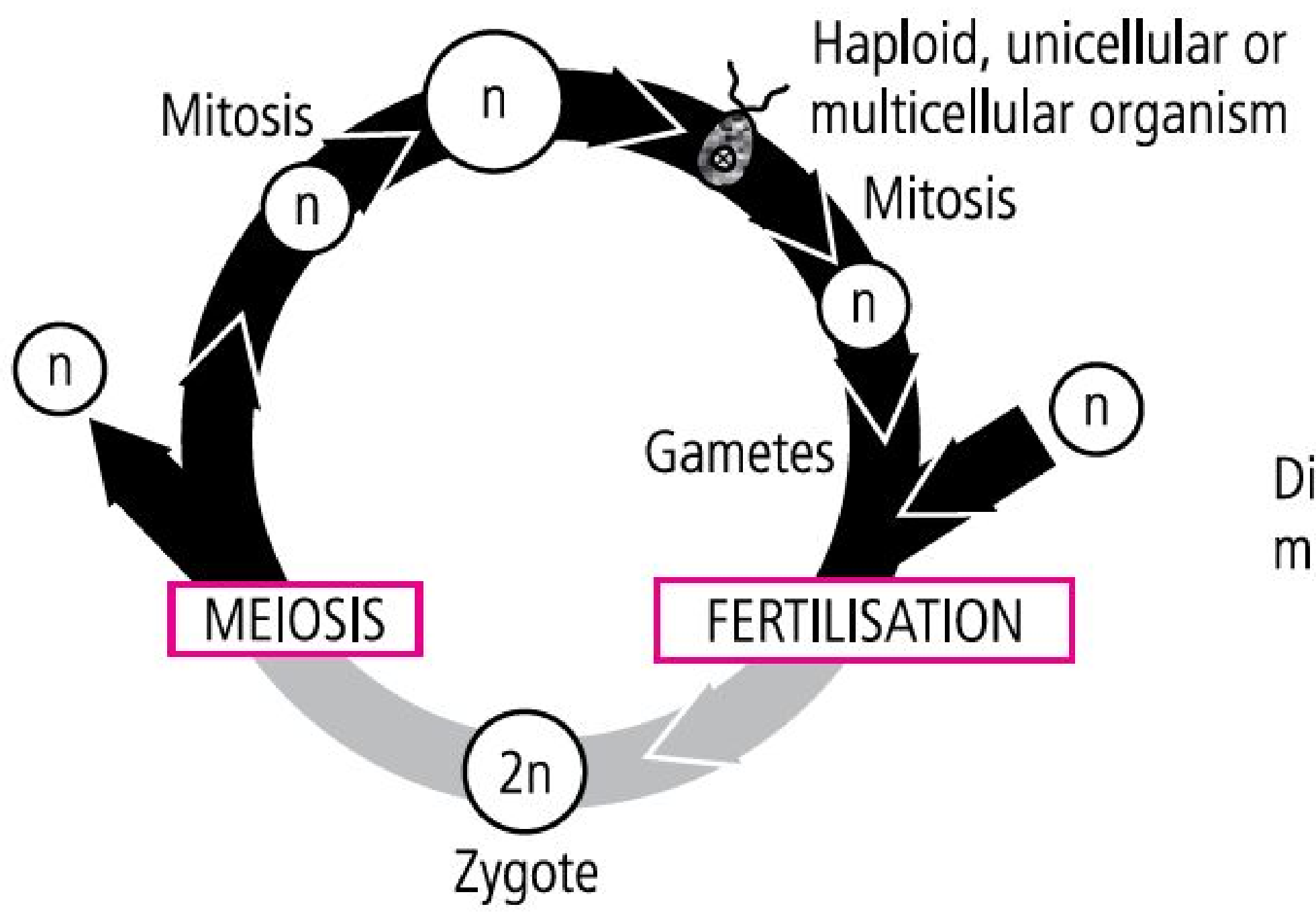
(vii) Double fertilisation and triple fusion found in angiosperms, do not occur in gymnosperms.

(viii) Free nuclear divisions occur in the zygote of gymnosperms but they do not occur in angiosperms.

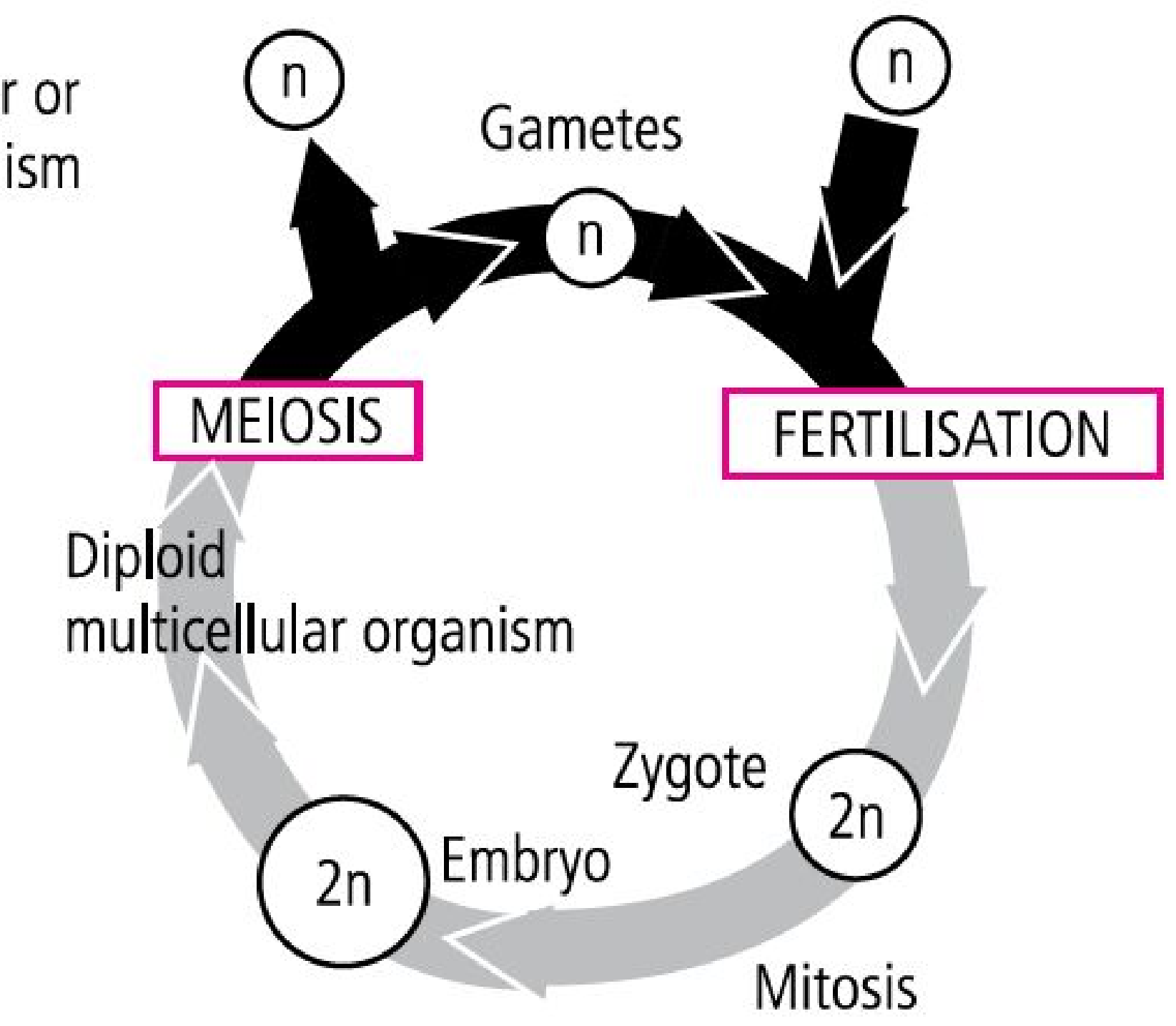
ALTERNATION OF GENERATION

– Different plant groups complete their life cycles in different patterns. The phases in which the life cycle is completed is called alternation of generations.

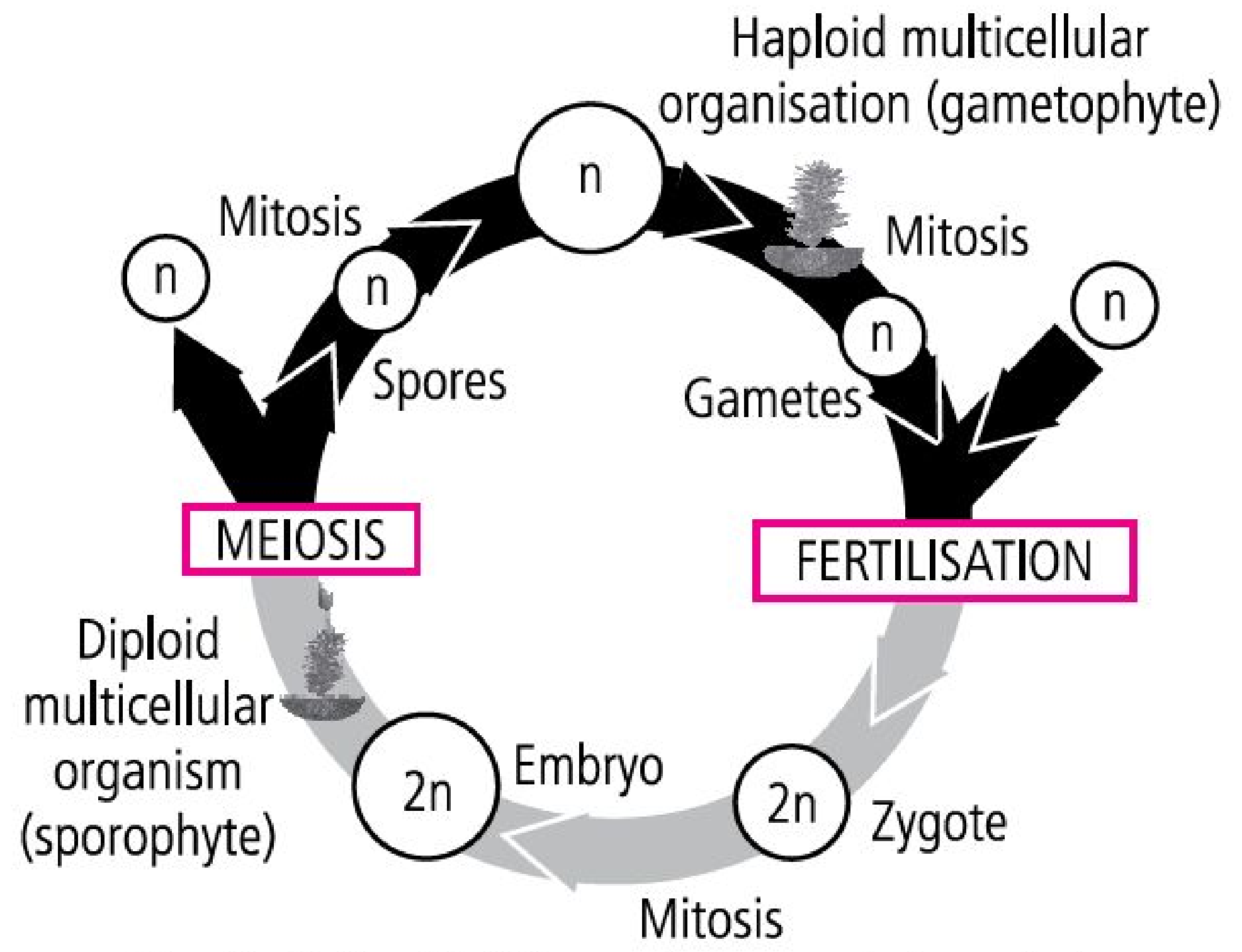
– It may be of three types in plants.


Mitosis
n
Haploid, unicellular or multicellular organism
n
Mitosis
n
n
Gametes
n
MEIOSIS
FERTILISATION
2n
Zygote

Haplontic life cycle occurs in many algae such as *Volvox*, *Spirogyra* and some species of *Chlamydomonas*.


n
Gametes
n
n
MEIOSIS
FERTILISATION
Diploid multicellular organism
Zygote
2n
2n
Embryo
Mitosis

Diplontic life cycle occur in seed bearing plants *i.e.*, gymnosperms and angiosperms and alga such as *Fucus*.


Haploid multicellular organisation (gametophyte)
Mitosis
n
Mitosis
n
n
Spores
n
Gametes
n
MEIOSIS
FERTILISATION
Diploid multicellular organism (sporophyte)
2n
Embryo
2n
Zygote
Mitosis

Haplodiplontic life cycle occurs in bryophytes, pteridophytes and some algae such as *Ectocarpus*, Kelps and *Polysiphonia*

INTEXT PRACTICE QUESTIONS

9. Mention the adaptations of angiosperms to land.

10. How many types of life cycle does green algae exhibit?

HEALTHIEST CHEESES

MOZZARELLA

Mozzarella cheese, a streched curd type of cheese, which originated in Italy, has a unique streching and melting properties.

Uses : Add it in caprese salad, which is made with fresh tomatoes, basil and balsamic vinegar.

RICOTTA

This creamy Italian cheese is made from the watery by-product of other cheeses. The easily digestible protein in ricotta comes mostly in the form of whey.

Uses : Delicious in salads, scrambled eggs, pasta and lasagna.

COTTAGE CHEESE

Cottage cheese is a soft, white cheese made from the loose curd of cow's milk.

Uses : It is usually spread on toast blended into smoothies, added to scrambled eggs, or used as a base for dips.

PARMESAN

Parmesan is made from raw, unpasteurized cow's milk that is aged for at least 12 months to kill harmful bacteria and produce a complex flavour.

Uses : Add to pastas and pizzas. Sprinkle it on eggs or spread slices on a cheese board.

GOAT CHEESE

Goat cheese, also known as chevre, is a tangy, soft cheese made from goats' milk.

Uses : Crumbled goat cheese can be added to salads, pizzas and eggs.

GOUDA

It is known for its mild and creamy flavour combined with its round shape and yellow colour.

Uses : Often used in homemade macaroni.

SWISS

Originated in Switzerland. This semihard cheese is typically made from cow's milk and features a mild, nutty taste.

Uses : You can eat it with fruit or add it to sandwiches, egg bakes, burger or French onion soup.

CHEDDAR

Cheddar cheese is made in the classical way tends to have a sharp, pungent flavour, often slightly earthy.

Uses : You can add it to charcuterie plates, vegetables dishes, burgers and eggs.

Check Your Vitals for NEET

CLASS XI

Maximise your chance of success in medical entrance exams by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

- Recall question or single concept question – indicated by a single finger.
- Application question or question which requires 2 concepts - indicated by 2 fingers.
- Application question or question which requires 3 or more concepts - indicated by 3 fingers.

UNIT-I : DIVERSITY IN THE LIVING WORLD - PART-I

CHAPTER-1 : THE LIVING WORLD

Multiple Choice Questions

1. The number of species that are known and described are about

(a) 7-9 million (b) 2-3 billion

(c) 1.7 - 1.8 million (d) 50 million.

2. Which of the following is/are correct about universal rules related to nomenclature?

(a) Biological names are written in Italics and are Greek in origin.

(b) The first word denotes the specific epithet and second word denotes the genus in the biological name.

(c) Name of the author is written after generic epithet in biological name.

(d) First word denotes the genus starts with a capital letter while the specific epithet starts with small letter.

3. Which of the following common features of organisms would place them under the same taxonomic category 'phylum chordata'?

(a) Notochord and dorsal hollow neural system

(b) Absence of notochord and ventral hollow nerve cord

(c) Notochord and ventral hollow neural system

(d) Notochord and dorsal double neural system

4. Ability to easily recognise groups such as plants or animals or dogs, cats or insects this is an example of

(a) nomenclature

(b) classification

(c) identification

(d) taxonomy.

5. Choose the incorrect option.

(a) The unit of classification is called a rank.

(b) Identification is insignificant before nomenclature of an organism.

(c) Groups represent category.

(d) Classification is not a single step process.

6. Diptera is related to genus __________.

(a) *Musca* (b) *Canis*

(c) *Felis* (d) *Panthera*

7. Which of the following is/are correct about species?

(a) Species is a lowest taxonomic category.

(b) Species lies above genus in the taxonomic hierarchy.

(c) It includes a group of individual organisms with fundamental dissimilarities.

(d) Human beings belong to genus *sapiens* which is grouped in the species *Homo*.

8. Choose the incorrect statement.

(a) For plants, scientific names are based on principles and criteria provided by International Code for Biological Nomenclature.

(b) Scientific names ensure that each organism has only one name.

(c) Carolus Linnaeus has provided binomial nomenclature

(d) Both (a) and (c)

9. The basics of taxonomy are

(a) identification and nomenclature only

(b) characterisation and identification only

(c) characterisation, identification, classification and nomenclature

(d) identification and classification only.

10. Which of the following rank contains organisms most similar to one another?

(a) Class (b) Genus
(c) Family (d) Species

11. Which one of the following animals correctly matched with its particular taxonomic category?

(a) Tiger - *tigris*, species
(b) Mango-Sapindales, class
(c) Humans - primata, family
(d) Housefly - *Musca*, order

12. Select the odd one out.

(a) Hominidae (b) Muscidae
(c) Sapindales (d) Poaceae

13. All animals belonging to various phyla are assigned to the highest category called

(a) Kingdom Plantae
(b) Kingdom Animalia
(c) Class mammalia
(d) Order Carnivora.

14. Which of the following combinations is correct for wheat?

(a) Genus : *Triticum*, Family : Anacardiaceae, Order : Poales, Class : Monocotyledonae
(b) Genus : *Triticum*, Family : Poaceae, Order : Poales, Class : Dicotyledonae
(c) Genus : *Triticum*, Family : Poaceae, Order : Sapinadales, Class : Monocotyledonae
(d) Genus : *Triticum*, Family : Poaceae, Order : Poales, Class : Monocotyledonae

15. The smallest taxon is called

(a) class (b) order
(c) genus (d) species.

Match The Columns

16. Match columns I with column II.

	Column I		Column II
A.	Family	(i)	*Tuberosum*
B.	Kingdom	(ii)	Polymoniales
C.	Order	(iii)	*Solanum*
D.	Species	(iv)	Plantae
E.	Genus	(v)	Solanaceae

17. Match Column I with Column II. (There can be more than one match for items in Column I).

	Column I		Column II
A.	Binomial	(i)	Insecta
B.	Class	(ii)	Scientific name
C.	Systematics	(iii)	Dicotyledonae
D.	Wheat	(iv)	Universal application
		(v)	Classification
		(vi)	Angiospermae
		(vii)	Nomenclature
		(viii)	Identification

Passage Based Questions

18. **(A)** Complete the given passage with appropriate words or phrases.

The diversity in the living world has made it essential to have a universal system of (i) , (ii) and classification that helps in understanding of the relationships among organisms. These all form the domains of (iii) which is often used interchangeably with taxonomy. Each organism is given two word name (iv) and (v) . Two (vi) belonging to same (vii) cannot have similar (viii) name. The original scientific names were taken from (ix) or (x) languages.

(B) Read the given passage and correct the errors, wherever present.

All animals belonging to various class are assigned to the highest category called Kingdom Animalia in the taxonomic system of animals. The Kingdom Plantae, on the other hand, is distinct, and comprises all plants from various genus. The taxonomic categories from genus to kingdom have been shown in descending order. These are broad categories. However, taxonomists have also developed sub-categories in this hierarchy to facilitate more sound and scientific placement of various taxa.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** The binomial nomenclature system is given by Carolus Linnaeus.
Reason : This naming system used a three word format.

20. **Assertion :** Characterisation, identification, classification and nomenclature are the basic processes of taxonomy.
Reason : Classification is the process by which anything is grouped into convenient categories based on some easily observable characters.

21. **Assertion :** Classification is necessary to study all living organisms.
Reason : In classification, individuals are grouped into categories.

22. **Assertion :** The number of common characteristics goes on decreasing when we go higher from species to kingdom.
Reason : Higher the taxa more are the characteristics that the members within the taxon share.

23. **Assertion :** Order is a taxonomic category that includes one or more class.
Reason : All the genera in a family have some similar features and co-related characters.

24. Assertion : Cats and dogs have some similarities.
Reason : Cats and dogs belong to the same Family Canidae.

25. Assertion : Species is a group of individuals with fundamental similarities.
Reason : *indica*, *leo* and *tuberosum* are specific epithet.

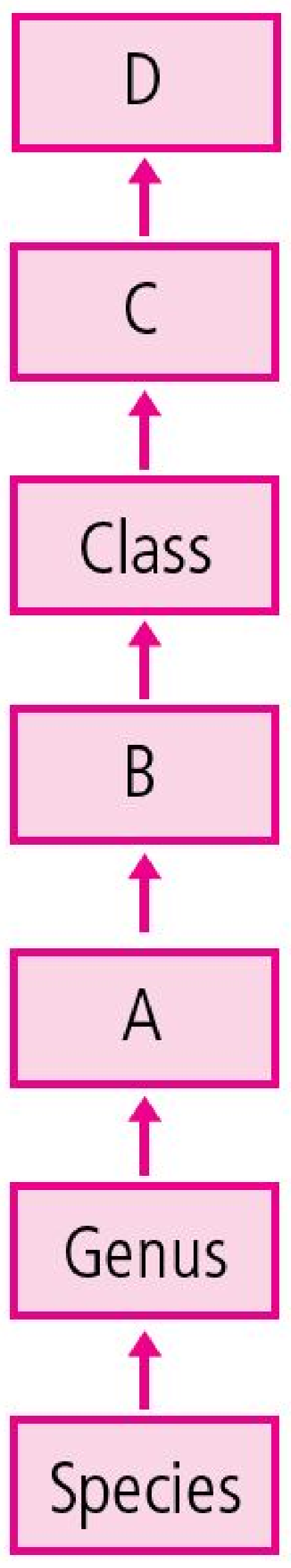
26. Assertion : In handwritten binomial nomenclature, both words are separately underlined.
Reason : Underlining the handwritten binomial nomenclature indicates its Latin origin.

27. Assertion : *Solanum* includes species like *nigrum* and *melongena*.
Reason : *Solanum* comprises a group of related genus.

28. Assertion : Binomial nomenclature is needed for all the living organisms.
Reason : A particular organism is known by the same name all over the world in binomial nomenclature.

Figure Based Questions

29. Refer to the given figure and answer the following questions.



(a) Identify A, B, C and D in the given figure.
(b) Define B in the given figure.
(c) Give the name of A, B and C for the genus *Triticum* and *Felis*.

30. Refer to the given table and answer the questions based on it.

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/Division
Housefly	*Musca domestica*	*Musca*	Muscidae	**A**	Insecta	**B**
Mango	*Mangifera indica*	*Mangifera*	**C**	Sapindales	Dicotyledonae	**D**

(a) Identify A, B, C and D.
(b) Define the term 'Genus'.
(c) Define the term 'Family'.

CHAPTER-2 : BIOLOGICAL CLASSIFICATION

Multiple Choice Questions

1. Dikaryon formation is characteristic of
(a) ascomycetes and basidiomycetes
(b) phycomycetes and basidiomycetes
(c) ascomycetes and phycomycetes
(d) phycomycetes and deuteromycetes.

2. Wheat rust is caused by
(a) *Puccinia* (b) *Ustilago*
(c) *Albugo* (d) *Phytophthora.*

3. Which of the following statements regarding cyanobacteria is incorrect?
(a) They are also called blue-green algae.
(b) They are chemosynthetic autotrophs.
(c) They form bloom in polluted water bodies.
(d) They are unicellular, colonial or filamentous.

4. Which of the following fixes atmospheric N_2?
(a) *Nostoc* (b) Algae
(c) Methanogens (d) None of these

5. Which of the following are the characters of dinoflagellates?
(i) Planktonic golden yellow algae with soap box like structure
(ii) Marine red biflagellated protista
(iii) Appear yellow, green, brown, blue and red in colour
(iv) Biflagellated organisms with pellicle
(v) Saprophytic or parasitic unicellular forms
(a) (i), (ii) and (iii) only (b) (ii), (iv) and (v) only
(c) (ii) and (iii) only (d) (ii) and (v) only

6. Which of the following class of fungi is being described by the given statements?
(i) They are found in aquatic habitats and on decaying wood in moist and damp places.

WHO AM I ...

1.	Phaeophyceae	Pg. 30
2.	Bryophytes	Pg. 38
3.	Spermiogenesis	Pg. 78
4.	IUI-Intra-Uterine Insemination	Pg. 83

(ii) Mycelium is aseptate and coenocytic.
(iii) Asexual reproduction takes place by zoospores (motile) or by aplanospores (non-motile).
(iv) Some common examples are *Mucor*, *Rhizopus* and *Albugo*.

(a) Ascomycetes (b) Phycomycetes
(c) Basidiomycetes (d) Deuteromycetes

7. With respect to fungal sexual cycle, choose the correct sequence of events.
(a) Karyogamy, Plasmogamy and Meiosis
(b) Meiosis, Plasmogamy and Karyogamy
(c) Plasmogamy, Karyogamy and Meiosis
(d) Meiosis, Karyogamy and Plasmogamy

8. Viruses possess
(a) inert crystalline structure inside the living cell.
(b) cellular organelle for its vital mechanism
(c) either DNA or RNA
(d) both RNA and DNA.

9. Which of the following statements are correct?
(i) Bacterial viruses or bacteriophages (viruses that infect the bacteria) are usually double stranded DNA viruses.
(ii) Prions are free RNA and they lack the protein coat that is found in viruses.
(iii) Viroids cause diseases like mumps, small pox, herpes and influenza.
(iv) The RNA of the viroid was of low molecular weight.

Choose the answer from the following options.
(a) (i) and (ii) (b) (i), (ii) and (iii)
(c) (i) and (iv) (d) (i), (ii), (iii) and (iv)

10. Dinoflagellates are ______ .
(a) marine only
(b) photosynthetic only
(c) both marine and photosynthetic
(d) chemoautotrophic

11. Which of the following are likely to be present in hot springs?
(a) Blue-green algae (b) Saprophytic fungi
(c) Archaebacteria (d) Eubacteria

12. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorised as
(a) cyanobacteria
(b) archaebacteria
(c) chemosynthetic autotrophs
(d) heterotrophic bacteria.

13. Euglenoids have their flexible body due to
(a) chlorophyll (b) cell wall
(c) pellicle (d) cellulose.

14. Select the correct match.
(a) Coccus – Rod-shaped
(b) Bacillus - Comma shaped
(c) Vibrium - Spherical shaped
(d) Spirillum - Spiral shaped

15. Which bear two unequal flagella?
(a) Euglenoids
(b) Slime moulds
(c) Diatoms
(d) Dinoflagellates

Match The Columns

16. Match column I with column II.

	Column I		Column II
A.	Phycomycetes	(i)	Fungi imperfecti
B.	Ascomycetes	(ii)	Mushrooms
C.	Basidiomycetes	(iii)	*Mucor*
D.	Deuteromycetes	(iv)	Sac fungi

17. Match the column I with column II. (There can be more than one match for items in column I.)

	Column I		Column II
A.	Kingdom Animalia	(i)	Antibiotics
B.	Prions	(ii)	Lichens
C.	Kingdom Plantae	(iii)	Holozoic
D.	Fungi	(iv)	Lacks cell wall
		(v)	Diploid sporophytic
		(vi)	Haploid gametophytic
		(vii)	*Puccinia*
		(viii)	Bovine spongiform encephalopathy (BSE)

Passage Based Questions

18. **(A)** Complete the given passage with appropriate words or phrases.

Slime moulds are (i). The body moves along (ii) twigs and leaves (iii) organic material. Under suitable conditions, they form an aggregation called plasmodium which may grow and spread over several feet. During unfavourable conditions, the (iv) differentiates and forms (v) bearing (vi) at their tips. The spores possess (vii). They are extremely (viii) and survive for many years, even under (ix) conditions. The spores are dispersed by (x).

(B) Read the given passage and correct the errors, wherever present.

Commonly known forms of basidiomycetes are mushrooms, sac-fungi or puffballs. They grow in water, on logs and tree stumps and in living plant bodies as parasites, *e.g.*, *Aspergillus* and smuts. The mycelium is coenocytic and aseptate. The asexual spores are generally not found, but vegetative reproduction by zoospores is common. The sex organs are absent, but karyogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotypes. The resultant structure is dikaryotic which ultimately gives rise to basidium. plasmogamy and meiosis take place in the basidium producing four basidiospores. The basidiospores are exogenously produced on the basidium. The basidia are arranged in fruiting bodies called basidiocarps.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** Cell wall of chrysophytes are indestructible.
Reason : Cell walls of chrysophytes have layer of magnesium pectate embedded in it.

20. **Assertion :** Mycoplasmas are pathogenic in animals and plants.
Reason : Mycoplasmas lack cell wall and can survive without oxygen.

21. **Assertion :** Several ruminant animals contain methanogens within their gut.
Reason : Methanogens help in the production of methane from dung of ruminants.

22. **Assertion :** Cyanobacteria are photosynthetic autotrophs.
Reason : Cyanobacteria have chlorophyll *a* and *b* similar to green plants.

23. **Assertion :** Archaebacteria are able to survive in harsh habitats.
Reason : Archaebacteria and other bacteria have same cell wall structure.

24. **Assertion :** Virus is an obligate parasite.
Reason : Virus is host specific.

25. **Assertion :** Deuteromycetes are known as fungi imperfecti.
Reason : In Deuteromycetes, only the asexual phase is known.

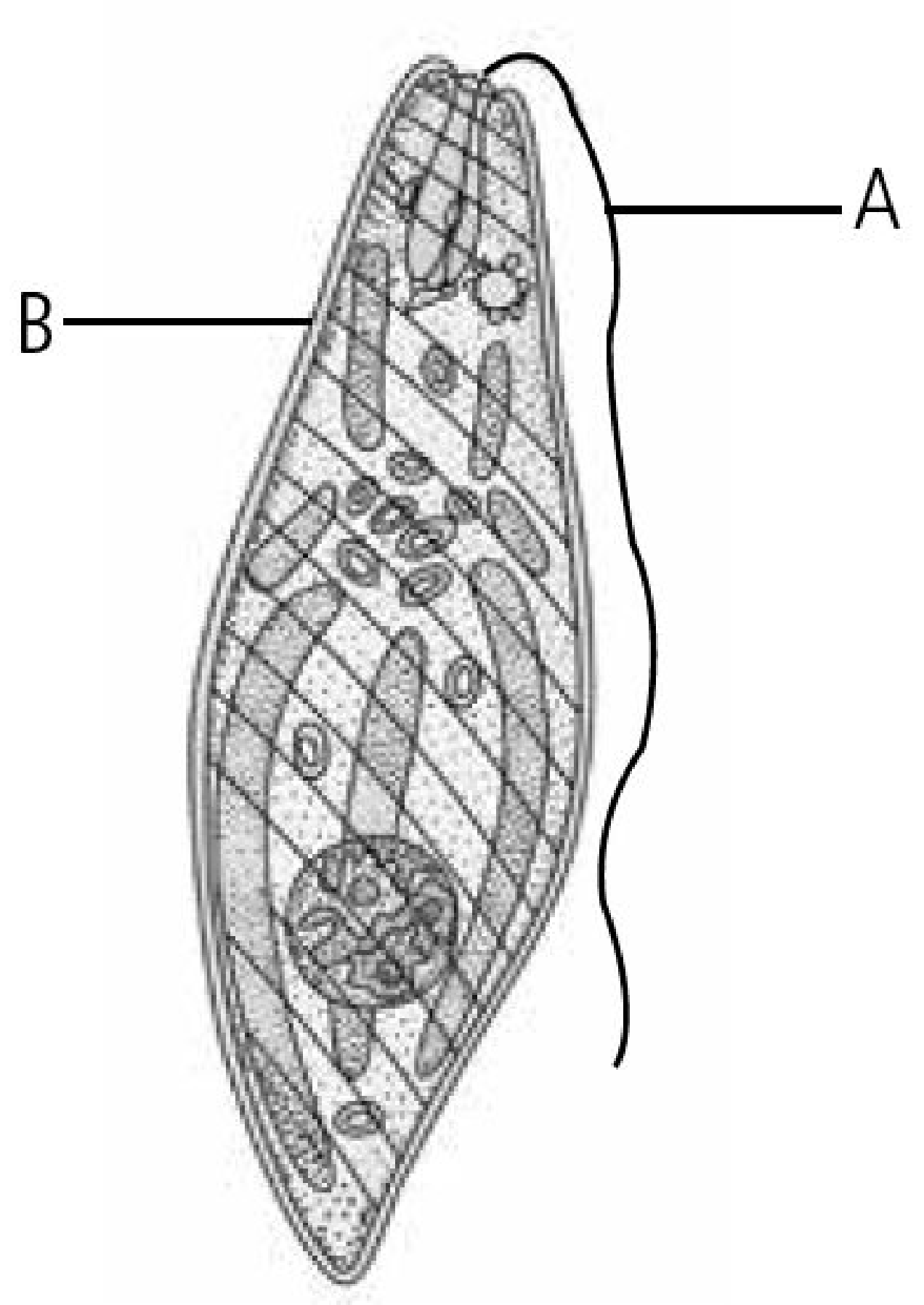
26. **Assertion :** *Euglena* is called as plant animal.
Reason : Pellicle of *Euglena* is made up of cellulose and not protein.

27. **Assertion :** Two kingdom classification was insufficient.
Reason : Majority of organisms did not fall into either of the categories in two kingdom classification.

28. **Assertion :** Phycomycetes are commonly known as sac fungi.
Reason : In Phycomycetes, zoospores or aplanospores are produced endogenously in sporangium.

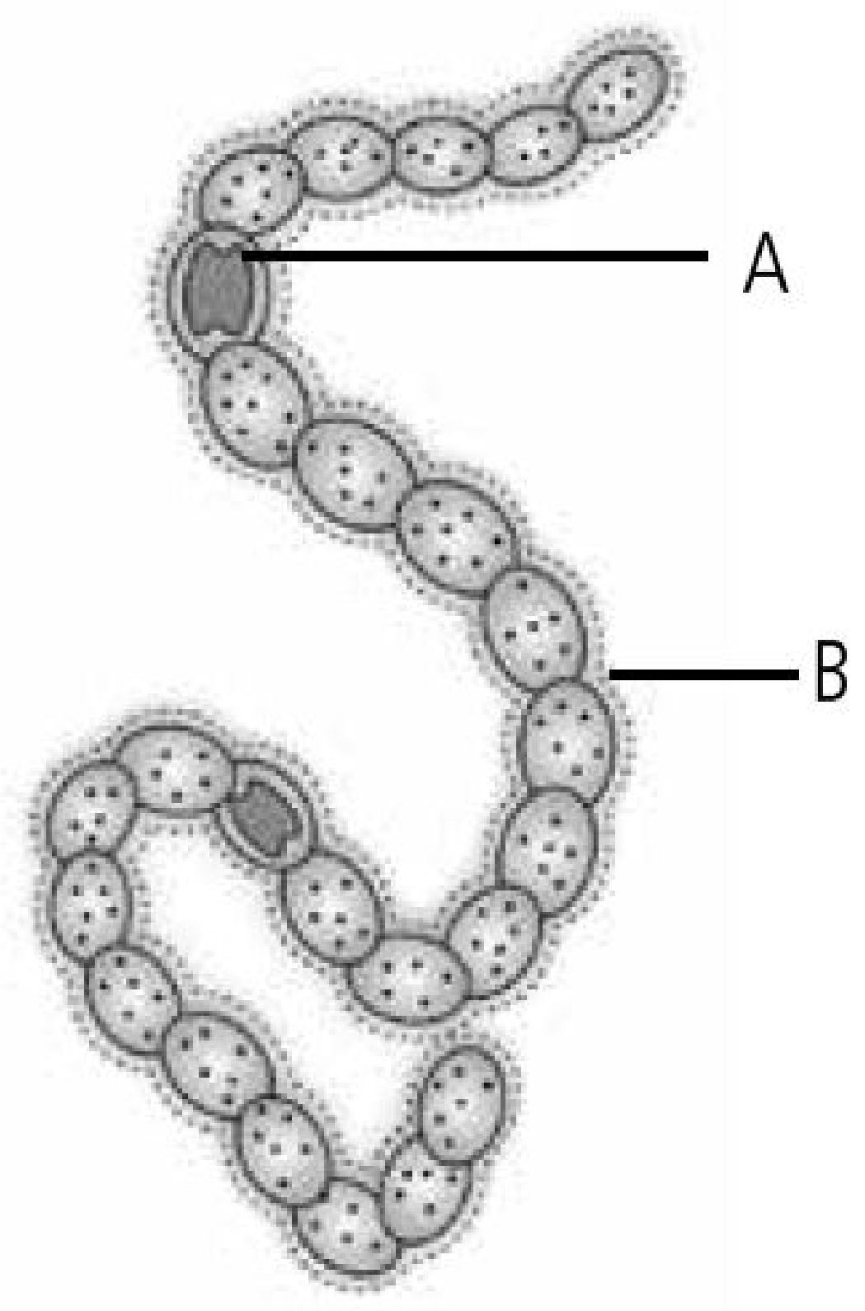
Figure Based Questions

29. Consider the given figure and answer the following questions.



(a) Identify A and B in the given figure.
(b) What is the function of B?
(c) What will happen if this organism is allowed to grow in dark?

30. Consider the given figure and answer the following questions.



(a) Identify A and B in the given figure.
(b) What is the function of the given organism?
(c) Write the characteristic features of the organism.

CROSS WORD ANSWER

APRIL 2025

Contributed by : Sushant Singh (Delhi)

ACROSS

1. Carboxylation
2. Action spectrum
3. Photo centre
5. Calvin cycle
8. NADPH
13. Photophosphorylation
15. Photorespiration
16. Chlorophyll *a*
18. Carbon fixation
19. Photosynthesis
20. Grana

DOWN

4. Cyclic Electron Flow
6. Photon
7. Antennae
9. Chloroplasts
10. Chemiosmosis
11. Reduction
12. Thylakoid
14. Light reactions
17. Stroma

SOLUTIONS

CHAPTER-1 : THE LIVING WORLD

1. (c) **2.** (d) **3.** (a) **4.** (b) **5.** (b)
6. (a) **7.** (a) **8.** (a) **9.** (c) **10.** (d)
11. (a) **12.** (c) **13.** (b) **14.** (b) **15.** (d)

16. A-(v), B-(iv), C-(ii), D-(i), E-(iii)

17. A-(ii),(iv); B-(i),(iii); C-(v, vii, viii); D-(vi)

18. **(A)** (i) nomenclature (ii) identification
(iii) systematics (iv) generic
(v) specific (vi) species
(vii) genus (viii) biological
(ix) Greek (x) Latin

(B) All animals belonging to various ~~class~~ phyla are assigned to the highest category called Kingdom Animalia in the ~~taxonomic~~ classification system of animals. The Kingdom Plantae, on the other hand, is distinct, and comprises all plants from various ~~genus~~ divisions. The taxonomic categories from ~~genus~~ species to kingdom have been shown in ~~descending~~ ascending order. These are broad categories. However, taxonomists have also developed sub-categories in this hierarchy to facilitate more sound and scientific placement of various taxa.

19. (c) **20.** (b) **21.** (a) **22.** (c) **23.** (d)
24. (c) **25.** (b) **26.** (a) **27.** (c) **28.** (a)

29. **(a)** The given figure is of taxonomical hierarchy. Here, A is Family, B is Order, C is Phylum/Division and D is Kingdom.

(b) Order is one of the obligate category in taxonomic hierarchy which includes one or more related families which exhibit a few similar characters.

(c) The family (A), order (B) and phylum/division (C) of *Triticum* is poaceae, poales and angiospermae respectively. While for *Felis* it is felidae, carnivora and chordata respectively.

30. **(a)** A-Diptera; B-Arthropoda; C-Anacardiaceae, D-Angiospermae.

(b) Genus is aggregate of closely related species which has more characters in common in comparison to species of other genera.

(c) Family has a group of related genera with still less number of similarities as compared to genus and species.

CHAPTER-2 : BIOLOGICAL CLASSIFICATION

1. (a) **2.** (a) **3.** (b) **4.** (a) **5.** (c)
6. (b) **7.** (c) **8.** (c) **9.** (c) **10.** (c)
11. (c) **12.** (d) **13.** (c) **14.** (d) **15.** (a)

16. A-(iii), B-(iv), C-(ii), D-(i)

17. A-(iii, iv); B-(viii); C-(v, vi); D-(i, ii, vii)

18. **(A)** (i) saprophytic protists (ii) decaying
(iii) engulfing (iv) plasmodium
(v) fruiting bodies (vi) spores
(vii) true walls (viii) resistant
(ix) adverse (x) air currents

(B) Commonly known forms of basidiomycetes are mushrooms, ~~sac-fungi~~ bracket fungi or puffballs. They grow in ~~water~~ soil, on logs and tree stumps and in living plant bodies as parasites, *e.g.*, ~~*Aspergillus*~~ rusts and smuts. The mycelium is ~~coenocytic~~ branched and ~~aseptate~~ septate. The asexual spores are generally not found, but vegetative reproduction by ~~zoospores~~ fragmentation is common. The sex organs are absent, but ~~karyogamy~~ plasmogamy is brought about by fusion of two vegetative or somatic cells of different strains or genotypes. The resultant structure is dikaryotic which ultimately gives rise to basidium. ~~Plasmogamy~~ Karyogamy and meiosis take place in the basidium producing four basidiospores. The basidiospores are exogenously produced on the basidium. The basidia are arranged in fruiting bodies called basidiocarps.

19. (c) **20.** (b) **21.** (b) **22.** (c) **23.** (c)
24. (b) **25.** (a) **26.** (c) **27.** (a) **28.** (d)

29. **(a)** The given figure is of *Euglena*. Here, A is flagella and B is pellicle.

(b) Instead of cell wall, they have a protein rich layer called pellicle which makes their body flexible.

(c) The nutrition in *Euglena*, is holophytic (photoautotrophic). When it is allowed to grow in dark, the photosynthetic form can feed on organic remains. Such mode of nutrition is known as mixotrophic.

30. **(a)** A-Heterocyst, B-Mucilagenous sheath

(b) *Nostoc* are photosynthetic autotrophs. They can fix atmospheric nitrogen in specialised cells called heterocysts.

(c) (i) They have rigid cell wall, unicellular, colonial or filamentous and are found in freshwater/marine or terrestrial algae.
(ii) They have chlorophyll similar to green plants, so they are photosynthetic autotrophs.

☺☺

Riddle ?

I am the gland that regulates metabolism and energy levels in the body. Who am I?

...search me ☺

Mind
Boggling Facts

- For the average person, it will take about 7 years to grow hair upto waist and 3 years to grow it to our shoulders.
- Hair is very elastic. Undamaged hair can stretch by around 60% before it breaks. If the hair is damaged, it can break much more easily.
- Sharks are older than trees. Sharks have been around for over 400 million years, while the first trees appeared about 350 million years ago.
- While most people think that parrots are large in size, not all species of parrots are big. The smallest species of parrot is just three inches long. Known as Pygmy parrots, these small, fast and agile birds originate from New Guinea and the surrounding Pacific islands where they forage for food in the foliage and thick bush.
- Pigeons are very good in recognising faces. Even with a change of clothes, pigeons are able to recognise particular faces. They seem to use this ability to stay away from people who aren't especially friendly.
- You've probably heard the phrase "sleep with one eye open," but its's not just a silly expression in the avian world. Some birds actually can sleep with one eye open, and some can even sleep in flight.
- Spider crabs are the masters of disguise: To survive, spider crabs use sponges, seaweed, and anything that will let them blend in, as camouflage that they stick to their carapace.
- Lobster can re-grow an eye or an arm. Just like the lizards or sea-stars, a lobster can regrow an eye or a claw it lost in the mouth of a predator. But the new one will be smaller than the first.
- Elephants may feed for upto 16 hours a day. In the wild one animal can consume as much as 600 pounds of food in a single day, although 250 – 300 pounds is a more typical amount
- Sharks have small black spots near the nose, eyes, and mouth. These spots are the ampullae of Lorenzini – special electroreceptor organs that allow the shark to sense electromagnetic fields and temperature shifts in the ocean.
- Koalas have fingerprints, they're the only animals other than primates that have them and just like us, each one is an individual. Scientists have hypothesized that they evolved fingerprints to help them navigate tree branches, while also harvesting the leaves that make up their diet (a specific age of eucalyptus).
- The largest and heaviest of all lizards is the Komodo dragon. These lizards reach about 10 feet long and 150 pounds. They are one of the few lizards with a venomous bite and can take down much larger mammals including buffalo and deer.
- Some seeds are toxic. Seeds, like those of the apple, contain small amounts of cyanide.
- Most modern fish are tetrachromatic. This means they see colour more vividly than us humans.
- Crabs are also known as "spiders of the sea" because, like crabs, spiders have legs that bend at joints.
- There are approximately 3,400 snake species in the world, out of which only about 600 are venomous. Out of those 600 venomous snakes, only 200 pose a serious threat to humans.
- Goose bumps occur when muscles at the base of each hair contract and pull the hair straight up. These tiny muscles are known as the Arrector Pili muscles.
- The cornea is the only part of the human body that has no blood supply. Cornea gets oxygen directly from the air. ☺☺

Riddle

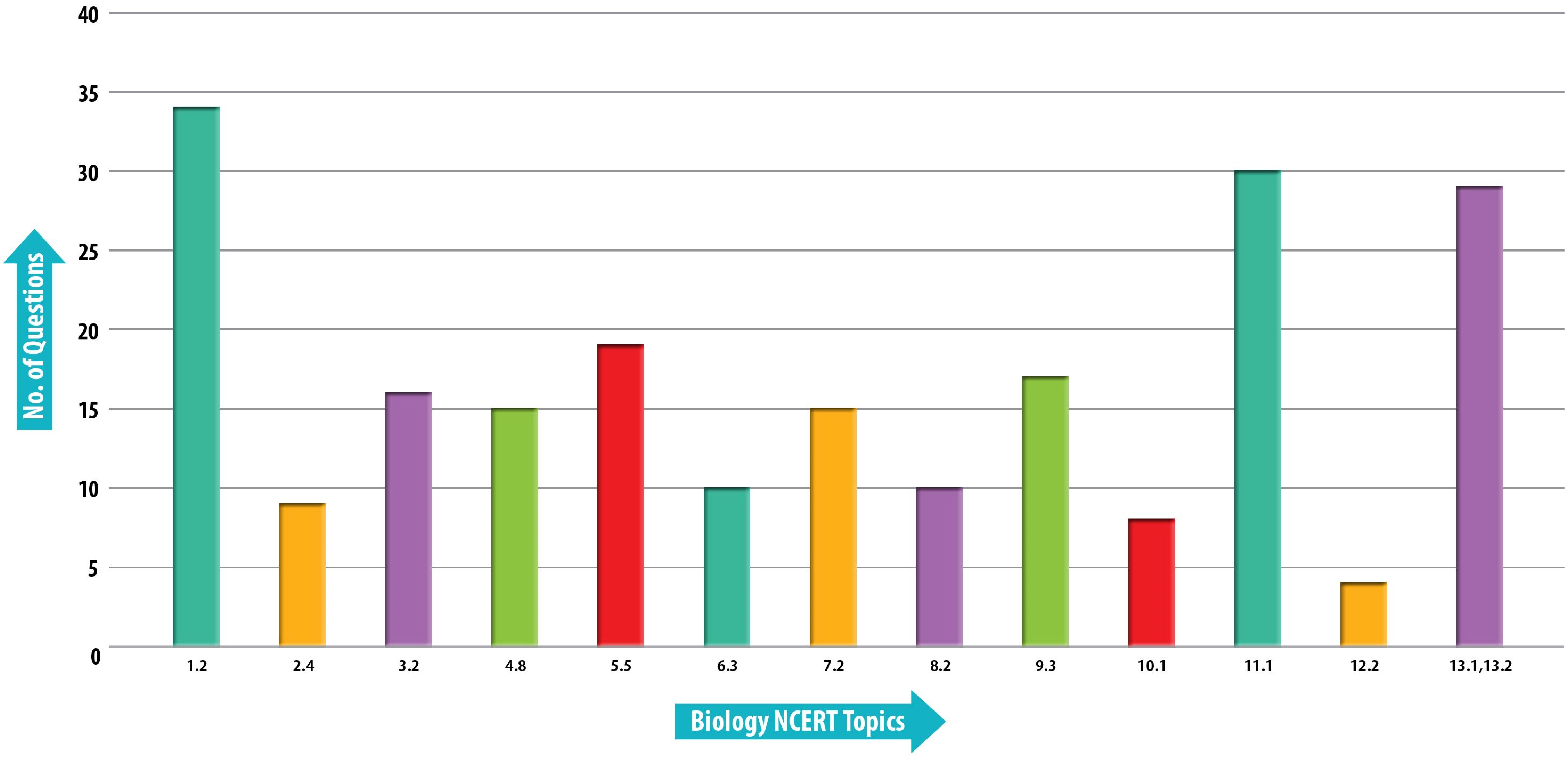
ANSWER

Thyroid gland Pg. 45

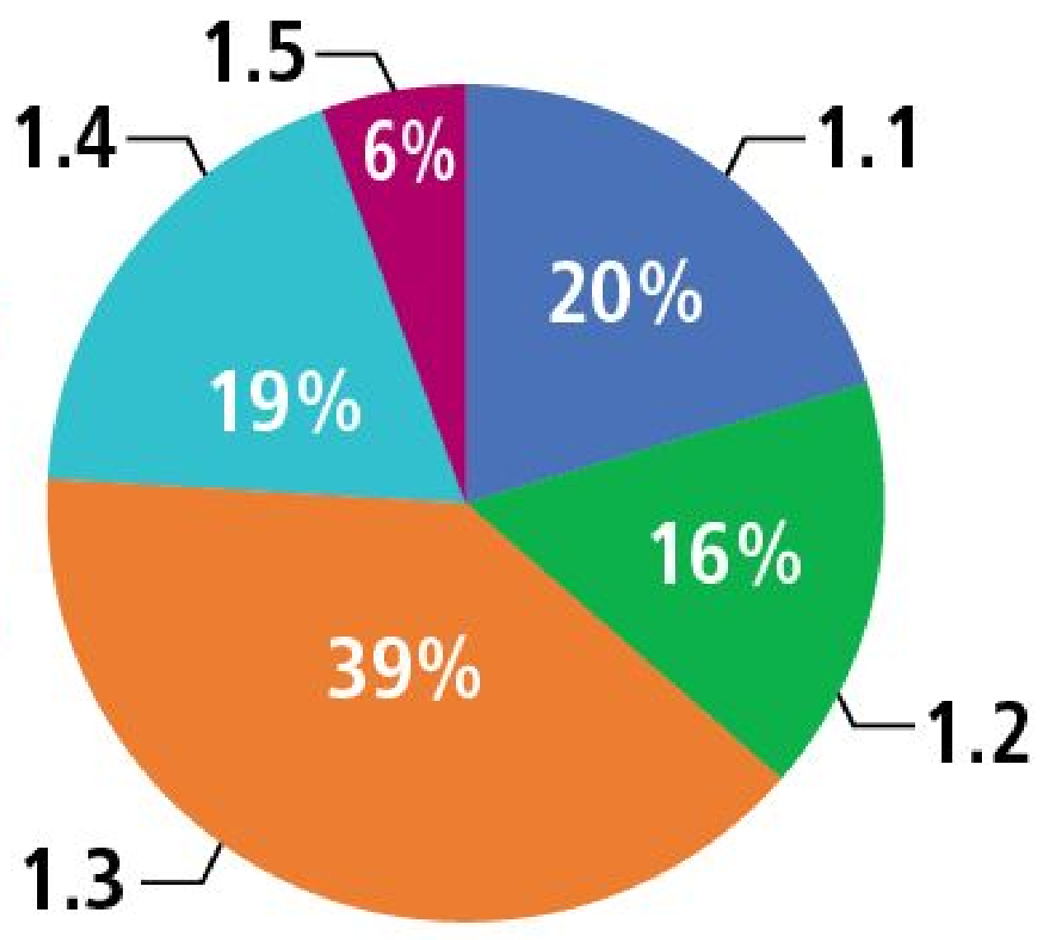
Are you ready for

NEET? Exam 2025

Past 10 Years
(2015-2024) Chapterwise
Trend Analysis of NEET
Questions

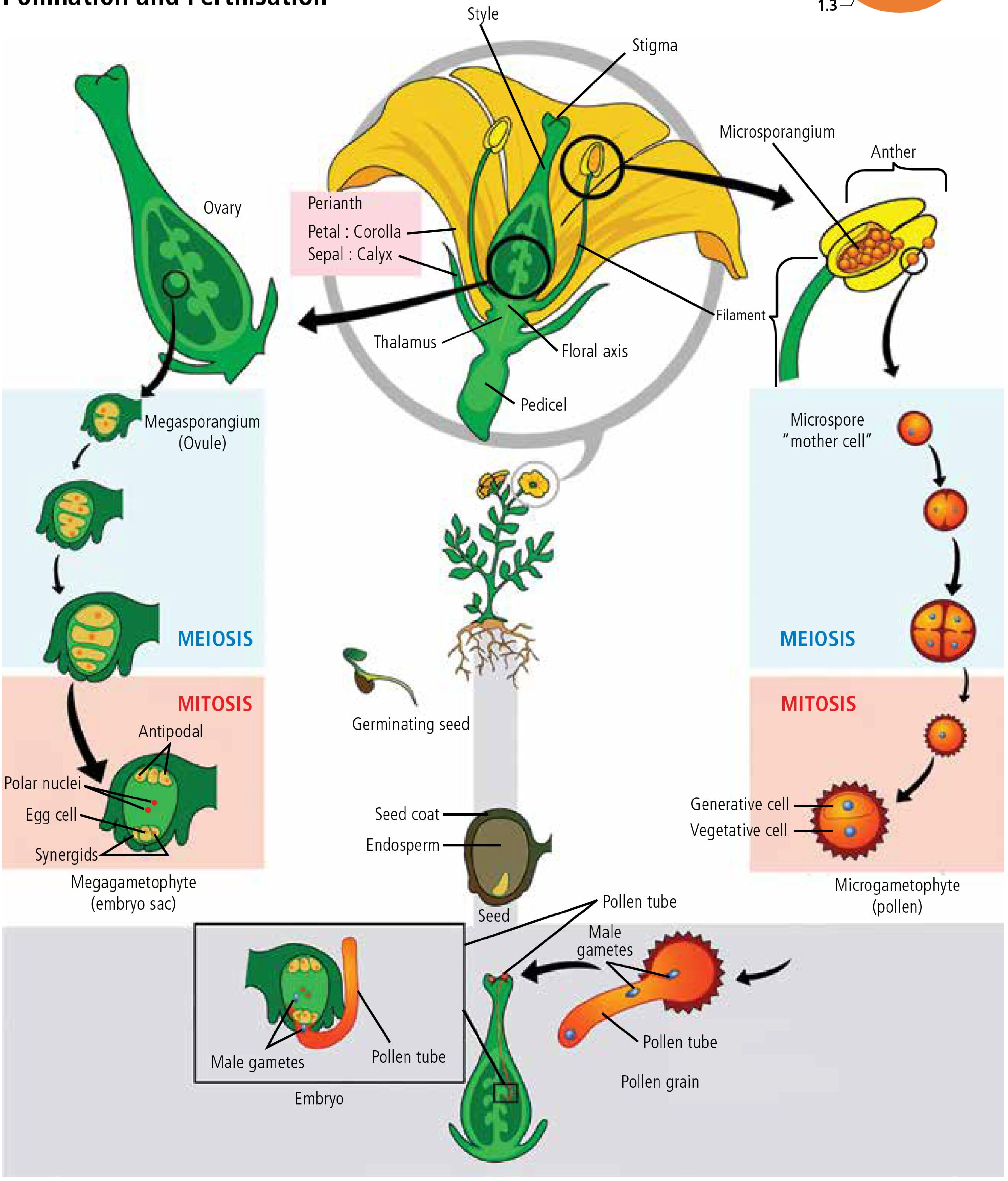


Some of the important topics extracted from the graphical analysis are explained here with HD images.

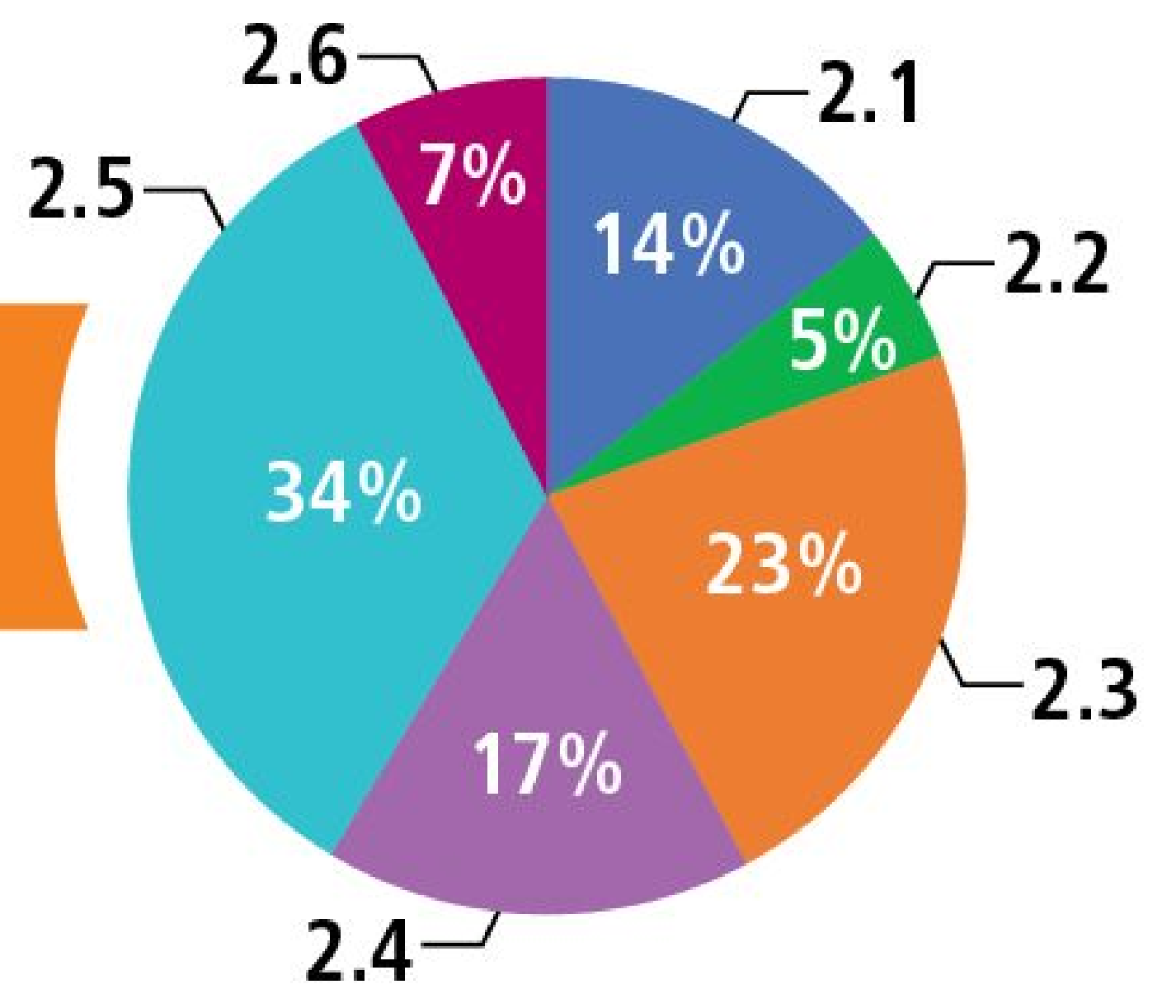


01 | Sexual Reproduction in Flowering Plants

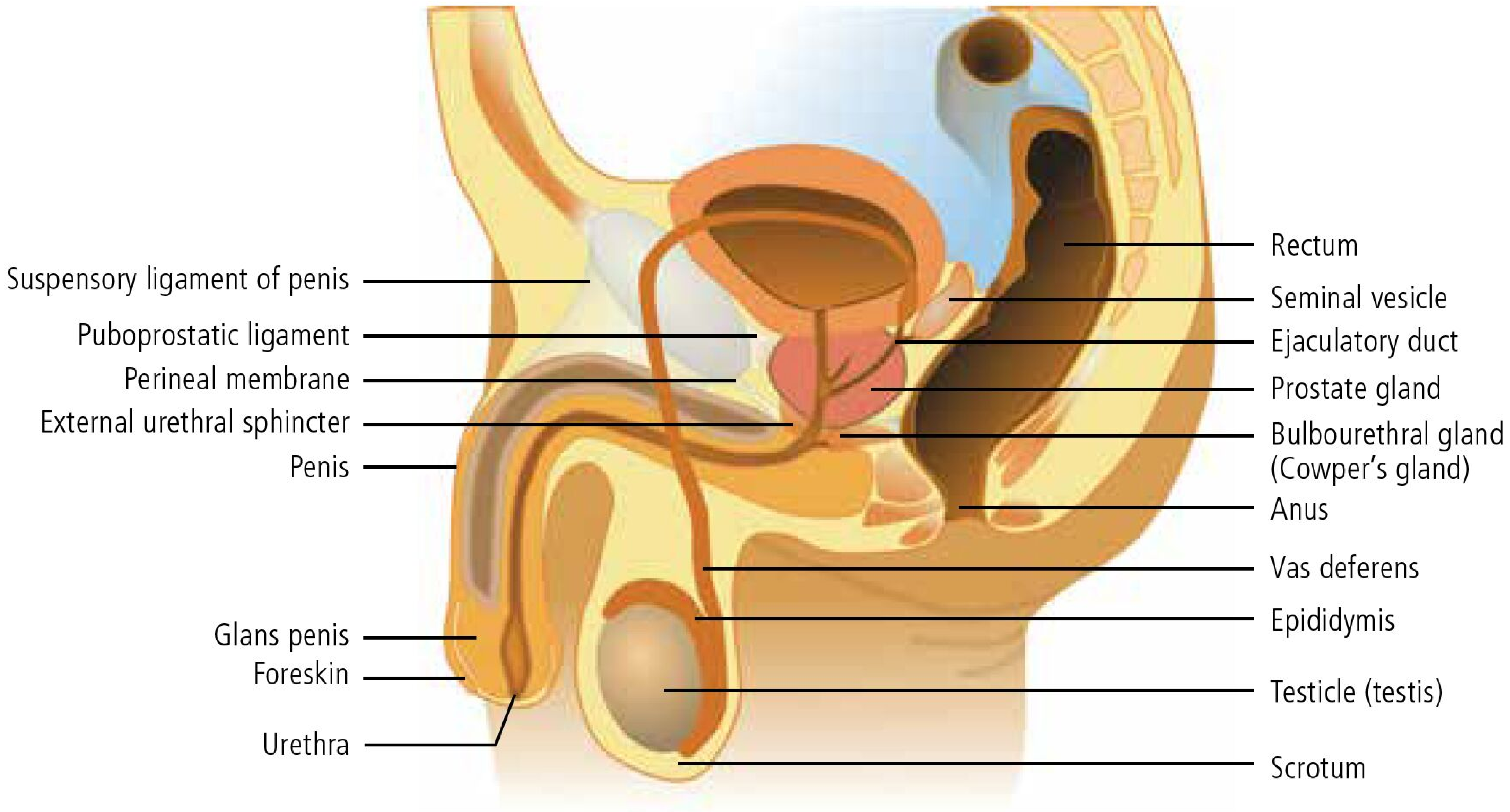
Pollination and Fertilisation


Style
Stigma
Microsporangium
Anther
Ovary
Perianth
Petal : Corolla
Sepal : Calyx
Filament
Thalamus
Floral axis
Pedicel
Megasporangium
(Ovule)
Microspore
"mother cell"
MEIOSIS
MEIOSIS
MITOSIS
MITOSIS
Antipodal
Polar nuclei
Egg cell
Synergids
Megagametophyte
(embryo sac)
Germinating seed
Seed coat
Endosperm
Seed
Generative cell
Vegetative cell
Microgametophyte
(pollen)
Pollen tube
Male
gametes
Male gametes
Pollen tube
Embryo
Pollen tube
Pollen grain

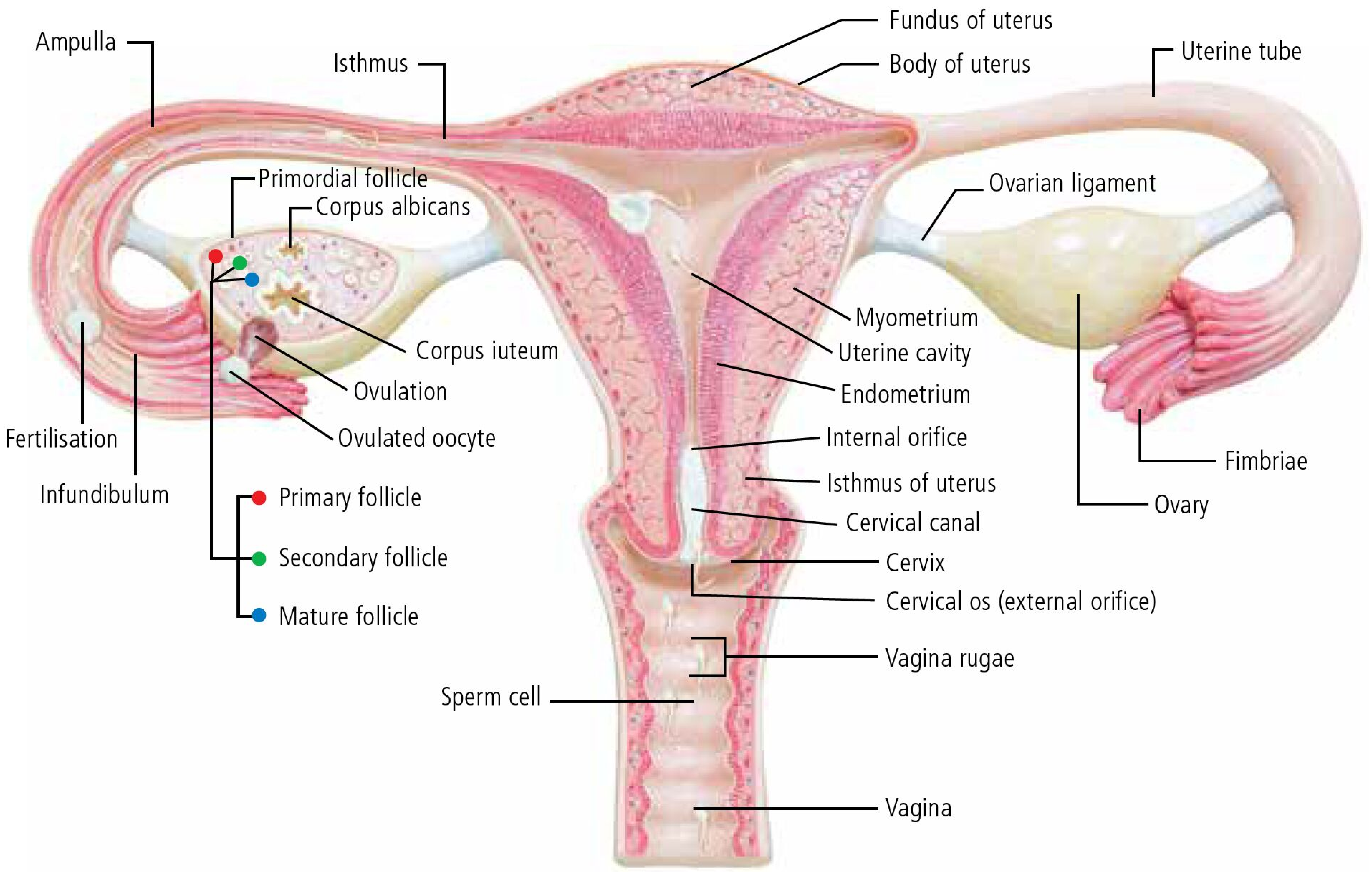
02 | Human Reproduction



Male Reproductive System


Suspensory ligament of penis
Puboprostatic ligament
Perineal membrane
External urethral sphincter
Penis
Glans penis
Foreskin
Urethra
Rectum
Seminal vesicle
Ejaculatory duct
Prostate gland
Bulbourethral gland (Cowper's gland)
Anus
Vas deferens
Epididymis
Testicle (testis)
Scrotum

Female Reproductive System


Ampulla
Isthmus
Fundus of uterus
Body of uterus
Uterine tube
Primordial follicle
Corpus albicans
Ovarian ligament
Corpus iuteum
Ovulation
Ovulated oocyte
Myometrium
Uterine cavity
Endometrium
Internal orifice
Isthmus of uterus
Cervical canal
Cervix
Cervical os (external orifice)
Fertilisation
Infundibulum
Fimbriae
Ovary
Primary follicle
Secondary follicle
Mature follicle
Vagina rugae
Sperm cell
Vagina

CONCEPT
MAP

Sexual Reproduction in Flowering Plants

All flowering plants show sexual reproduction. Sexual reproduction is the process of development of new organisms through the formation and fusion of gametes. In angiospermic plants, flowers are specialised to perform sexual reproduction. A typical flower consists of four whorls, *i.e.*, calyx, corolla, androecium and gynoecium, of which the last two represent male and female reproductive organs, respectively.

Pre-Fertilisation Events

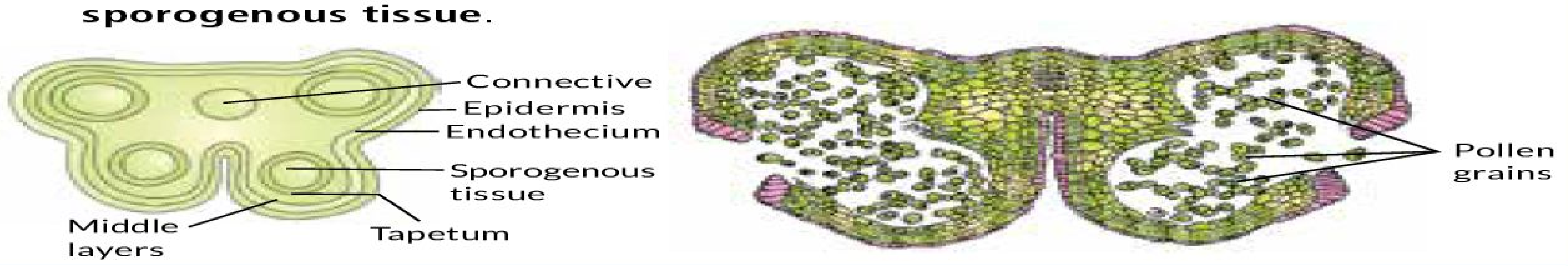
Sporogenesis

Microsporogenesis

The process of formation of microspores from sporogenous tissue is known as microsporogenesis. It takes place inside microsporangium.

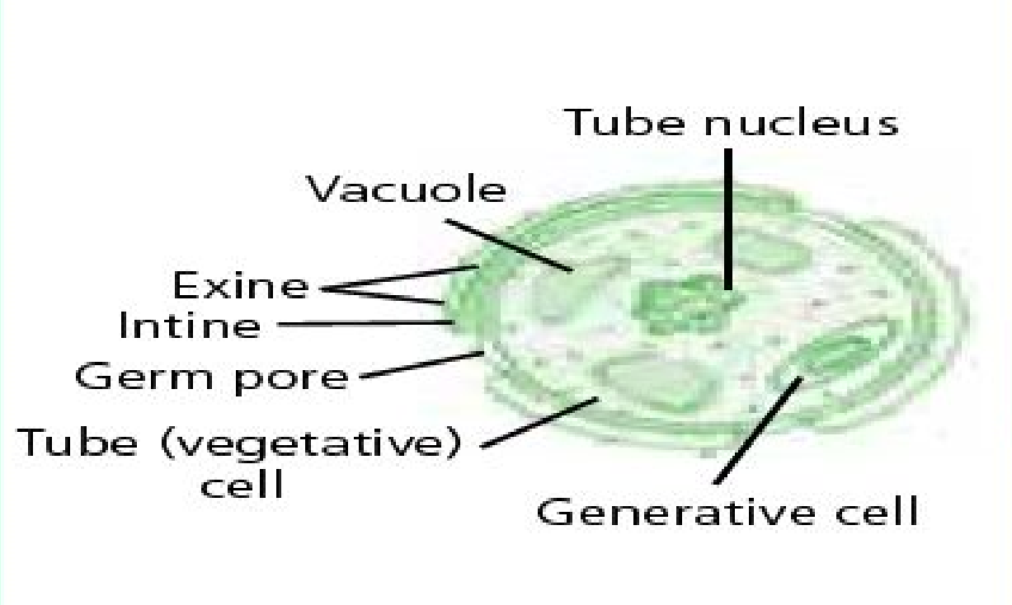
Microsporangium

- Microsporangium consisting of outer **microsporangial wall** and inner homogenous **sporogenous tissue**.


Connective
Epidermis
Endothecium
Sporogenous tissue
Middle layers
Tapetum
Pollen grains

Microspore

- It consists 2-layered wall.
- Outer layer **exine** is made up of **sporopollenin** (a highly resistant fatty substance that is not degraded by any enzyme, unaffected by high temperature, strong acid etc.
- Inner layer **intine** is **pectocellulosic** in nature.
- At certain areas exine is either absent or thin. These areas are called **germ pores**.


Tube nucleus
Vacuole
Exine
Intine
Germ pore
Tube (vegetative) cell
Generative cell

Megasporogenesis

It involves formation of haploid megaspores inside megasporangium.

Megasporangium

- **Ovule** present inside the ovary serves as **integumented megasporangium**. It develops into seeds after fertilisation.
- Ovule is attached to **placenta** (a parenchymatous cushion) and consists of a **funiculus** (stalk), **integuments** (wall layers) and **nucellus** (parenchymatous tissue).
- Integuments leave a narrow pore at one end of ovule, known as **micropyle**.
- A cell towards micropylar end of nucellus develops into **primary archesporial cell** which divides mitotically to form outer **primary parietal cell** and inner **primary sporogenous cell**.

Megaspore

- Haploid cell that serves as the first cell of female gametophyte.
- It forms the gametophyte while still retained inside the spore and never separates from the parent plant.

Gametogenesis

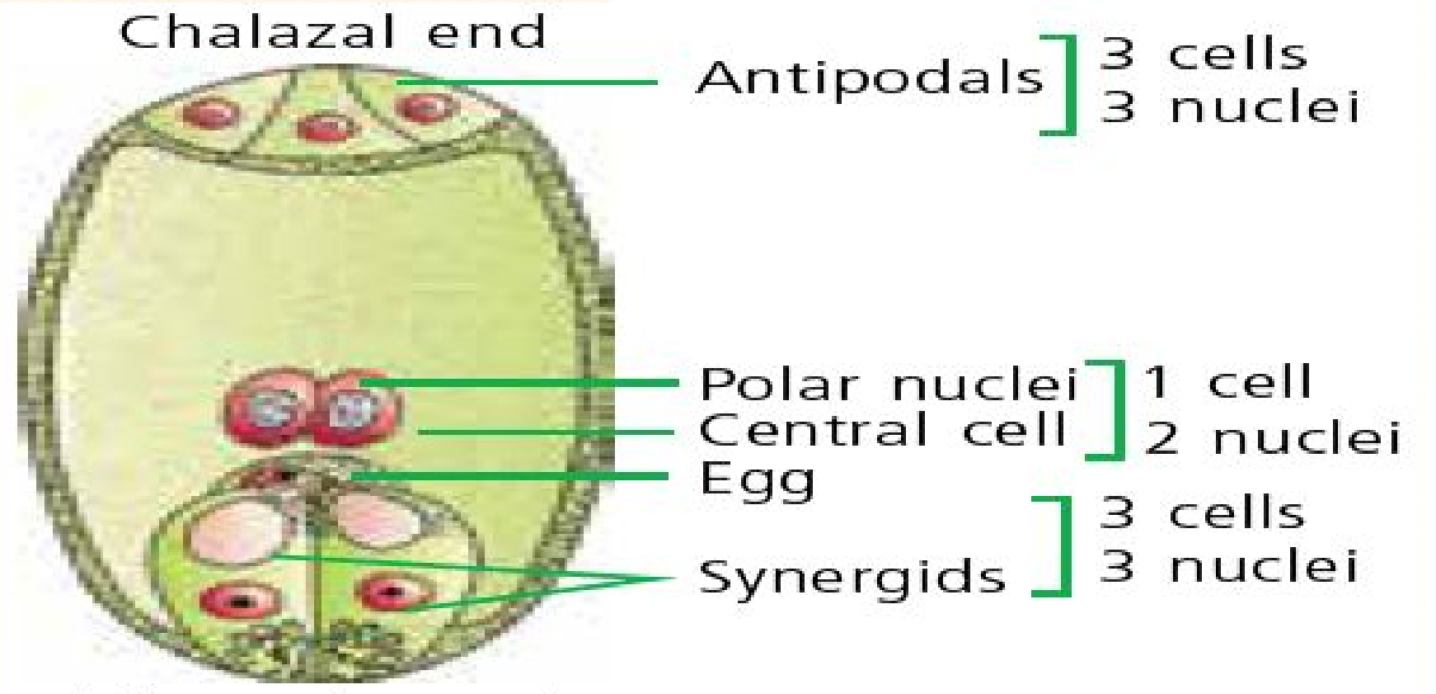
Gametogenesis (gamete formation) occurs inside the female and male gametophytes structures that are retained within the spores itself.

Development of male gametophyte

- Inside the microspore, mitosis occurs and a 2-celled male gametophyte large one tube cell or vegetative cell and the small one generative cell is formed.
- This division occurs when microspores are still inside the pollen sac.
- Microspores are shed 2-celled stage or 3-celled stage. Later, development of male gametophyte occurs after pollination.

Development of female gametophyte

- The megaspore grows in size and divides by mitosis to form 2- nucleated cell. This 2-nucleated cell forms embryo sac, the female gametophyte.
- Each nucleus moves to either poles and divides there twice to form 8 nucleate embryo sac.
- One nucleus each from both poles migrates to centre; the nuclei are termed **polar nuclei**.
- Three nuclei at **micropylar end** form egg apparatus : an **egg cell** and two **synergids cells**. Three nuclei at **chalazal end** form three **antipodal cells**.


Chalazal end
Antipodals
3 cells
3 nuclei
Polar nuclei
Central cell
1 cell
2 nuclei
Egg
Synergids
3 cells
3 nuclei
Micropylar end

Pollination

The term pollination refers to the process of transfer of pollen grains from anther and their deposition onto the stigmatic surface of the flower. It is a pre-requisite for fertilisation.

Types of pollination

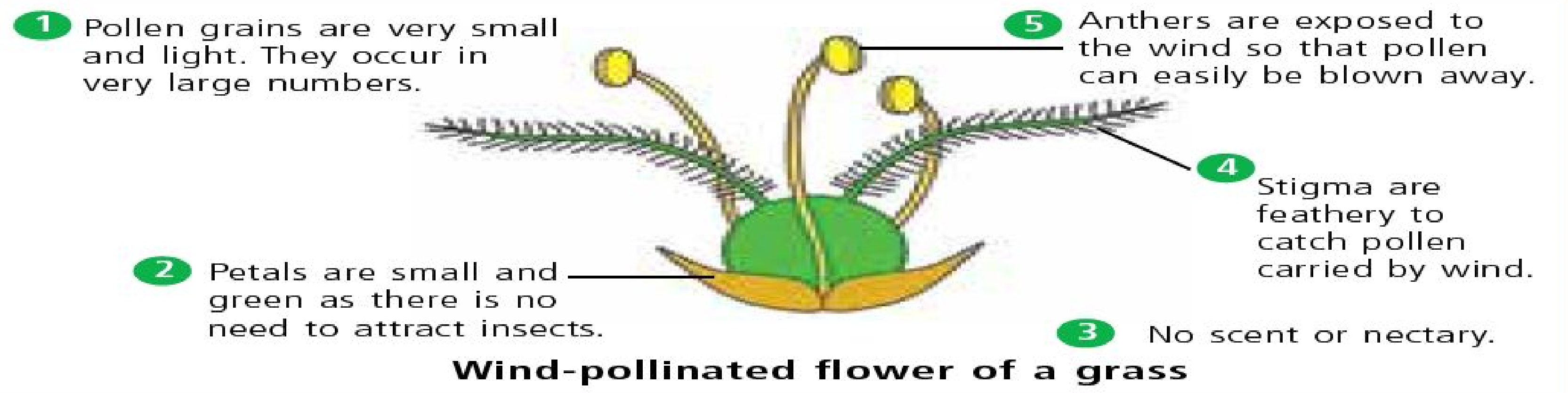
Autogamy
Pollen grains are transferred from anther to the stigma of the same flower.

Geitonogamy
Pollination takes place between the two flowers of the same plant.

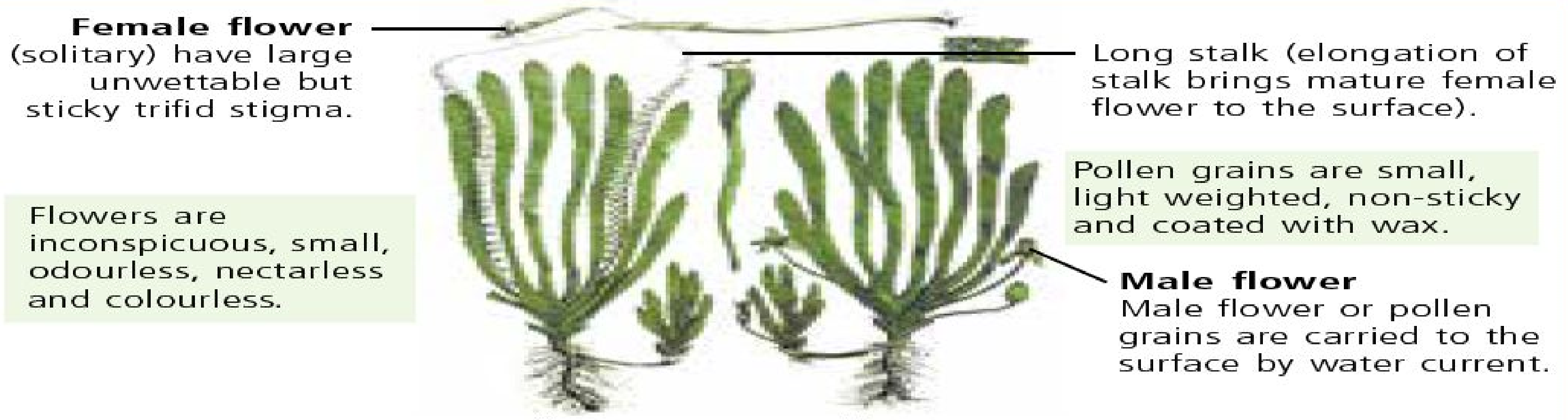
Xenogamy
Pollen grains transferred to the stigma of a different flower of another plant.

Agents of pollination

Biotic agents (animals) or abiotic agents (wind or water).


1 Pollen grains are very small and light. They occur in very large numbers.
5 Anthers are exposed to the wind so that pollen can easily be blown away.
4 Stigma are feathery to catch pollen carried by wind.
2 Petals are small and green as there is no need to attract insects.
3 No scent or nectary.

Wind-pollinated flower of a grass


Female flower (solitary) have large unwettable but sticky trifid stigma.
Long stalk (elongation of stalk brings mature female flower to the surface).
Pollen grains are small, light weighted, non-sticky and coated with wax.
Flowers are inconspicuous, small, odourless, nectarless and colourless.
Male flower
Male flower or pollen grains are carried to the surface by water current.

Pollination in *Vallisneria*

Fertilisation

Double fertilisation → Syngamy + Triple fusion
or Generative fertilisation, or Vegetative fertilisation

Syngamy → Male gamete (n) + Egg (n) = Zygote (2n)

Triple fusion → Male gamete (n) + 2 polar nuclei or secondary nucleus (2n) = Primary endosperm nucleus (3n)

Post-Fertilisation Events

The events that takes place after fertilisation such as fading of flower, withering of petals, stamens and style, etc., are collectively called post-fertilisation events. Most important of them occurs sequentially as endosperm formation, embryo development and seed formation.

Seeds

Endospermic or albuminous
Endosperm not exhausted by the developing embryo. Cotyledons are thin here. *E.g.*, seeds of wheat, barley, castor, poppy, etc.

Non-endospermic or non-albuminous
During the development of embryo, the food exhausted by the developing embryo. *E.g.*, seeds of gram, pea, bean, orchid, etc.

Embryogenesis

- The process of development of embryo from zygote or oospore is called embryogenesis.
- Generally the zygote (oospore) divides immediately after the first division of the primary endosperm nucleus.
- The early developmental stages of the embryos of monocots and dicots have no fundamental differences. But in later stages, there is a marked difference between the embryos of dicotyledonous and monocotyledonous plants.

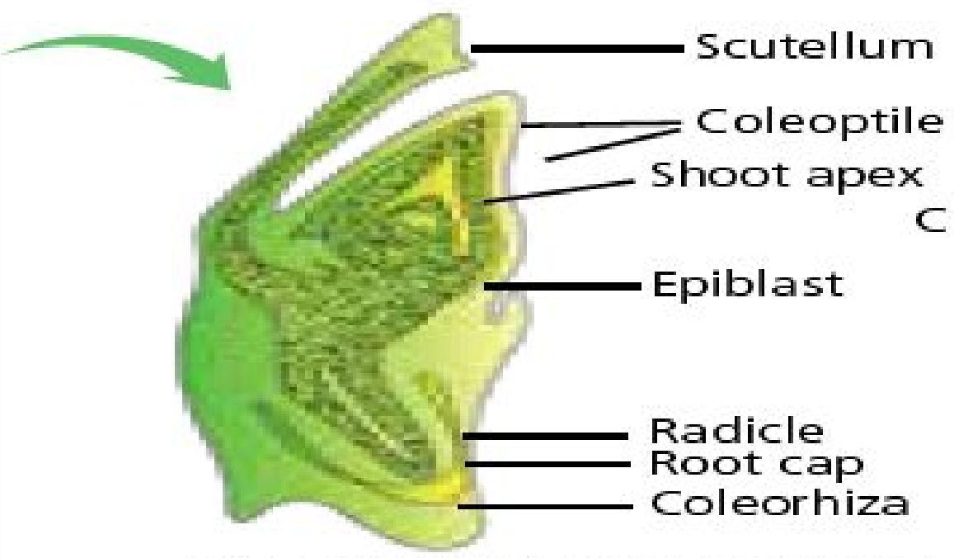

Scutellum
Coleoptile
Shoot apex
Epiblast
Radicle
Root cap
Coleorhiza

Fig. : Typical monocot embryo

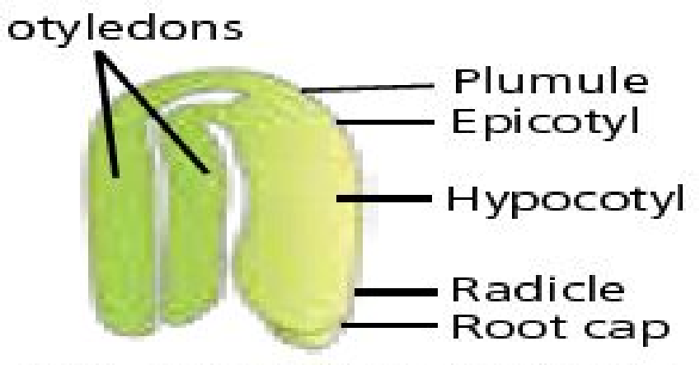

Cotyledons
Plumule
Epicotyl
Hypocotyl
Radicle
Root cap

Fig. : Typical dicot embryo

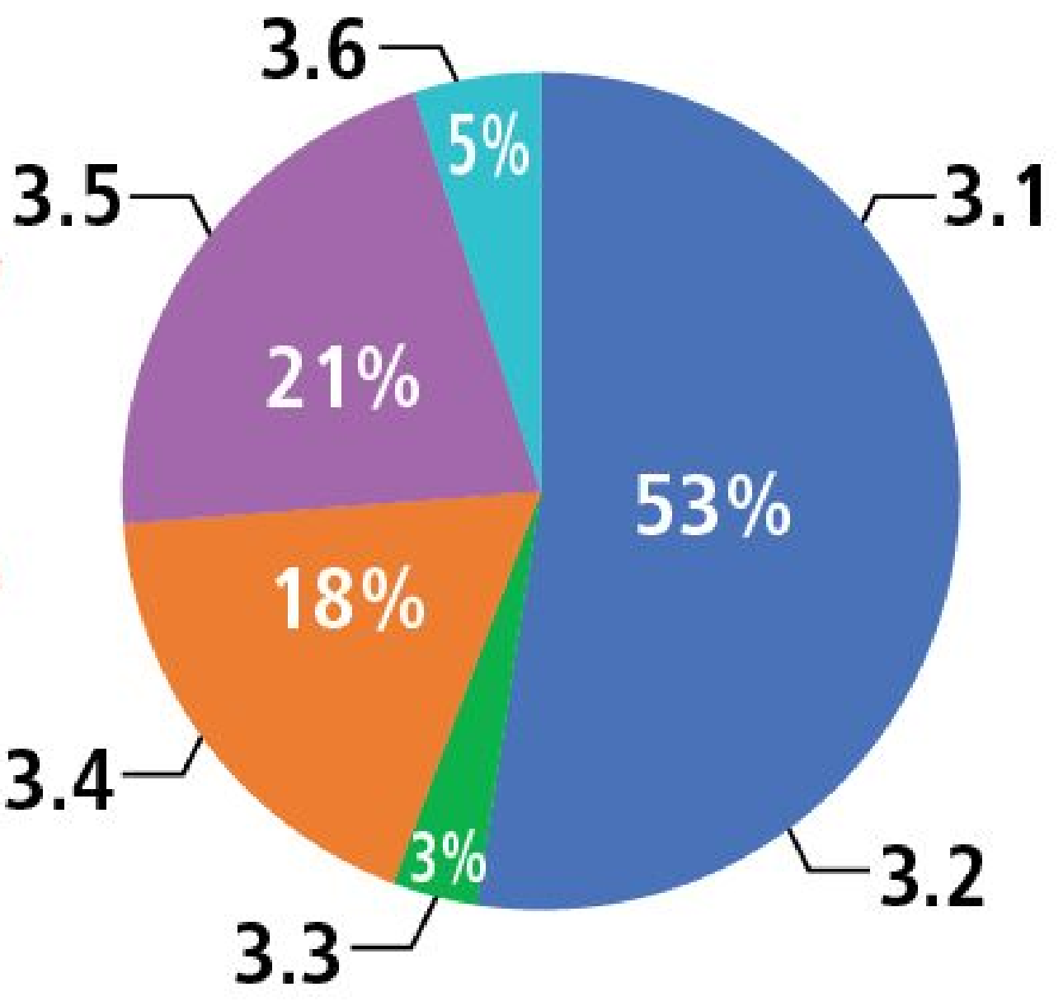
Endosperm

- As a consequence of triple fusion, a triploid structure called primary endosperm nucleus (PEN) is formed that divides by mitotic divisions and forms a mass of nutritive cells called the endosperm.
- Endosperm development precedes embryo development. Endosperm accumulates food reserves and functions as the nutritive tissue for the developing embryo. It is two types— Nuclear (tender coconut) and Cellular (White kernel of coconut).

Apomixis and Polyembryony

Apomixis is a special mechanism to produce seeds without fertilisation, *e.g.*, some species of Asteraceae and grasses. Occurrence of more than one embryo in a seed referred to as polyembryony *e.g.*, *Citrus* and mango.

03 | Reproductive Health



Population Stabilisation and Birth Control

Population stabilisation is the state when the birth rate and death rate becomes equal and population size remains unaltered. Birth control is the regulation of conception by preventive methods or devices to limit the number of offspring. Various contraceptive methods are:

Natural methods

It works on the principle of avoiding chances of ovum and sperms meeting.

Types: Periodic abstinence; Coitus interruptus or Withdrawal method; Lactational amenorrhea method

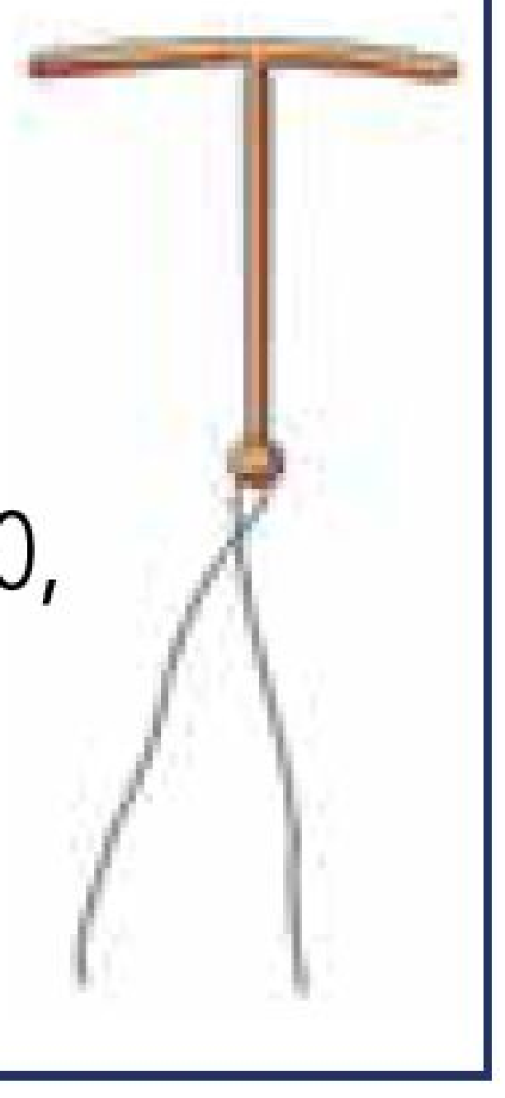
Barrier methods

Ovum and sperms are prevented from physically meeting with the help of some barriers. *E.g.*, Condoms, diaphragms, cervical caps and vaults

Chemical methods

Spermicidal creams, jellies and foams are usually used along with the barriers to increase their contraceptive efficiency.

Intrauterine Devices (IUDs)

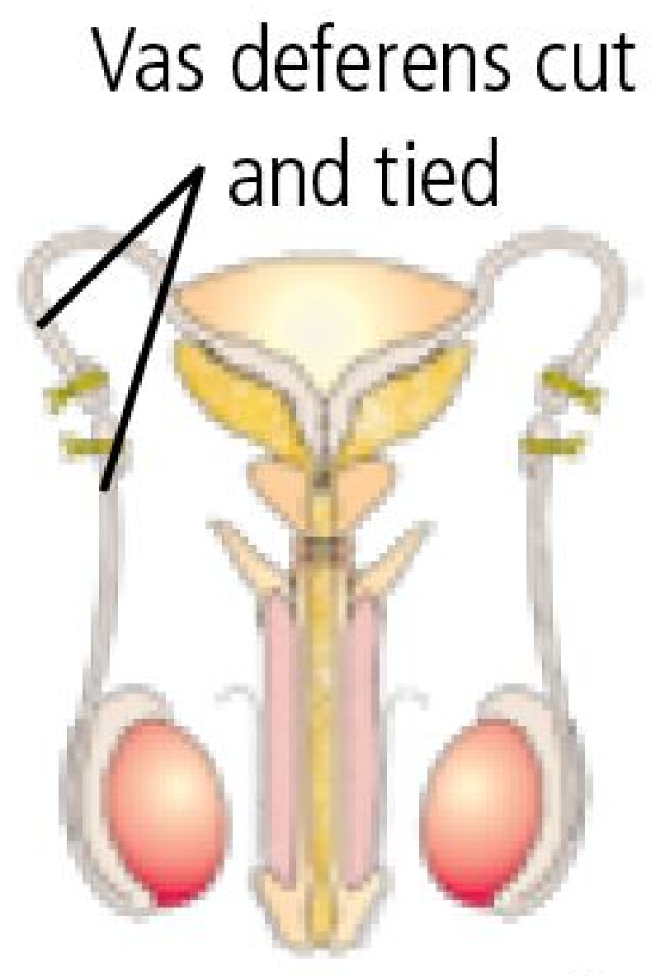


Increase phagocytosis of sperms within uterus. Non-medicated IUDs: *e.g.*, (Lippes' loop); Hormone releasing IUDs : *e.g.*, LNG-20, progestasert; Copper releasing IUDs : *e.g.*, CuT, Cu7, Multiload 375

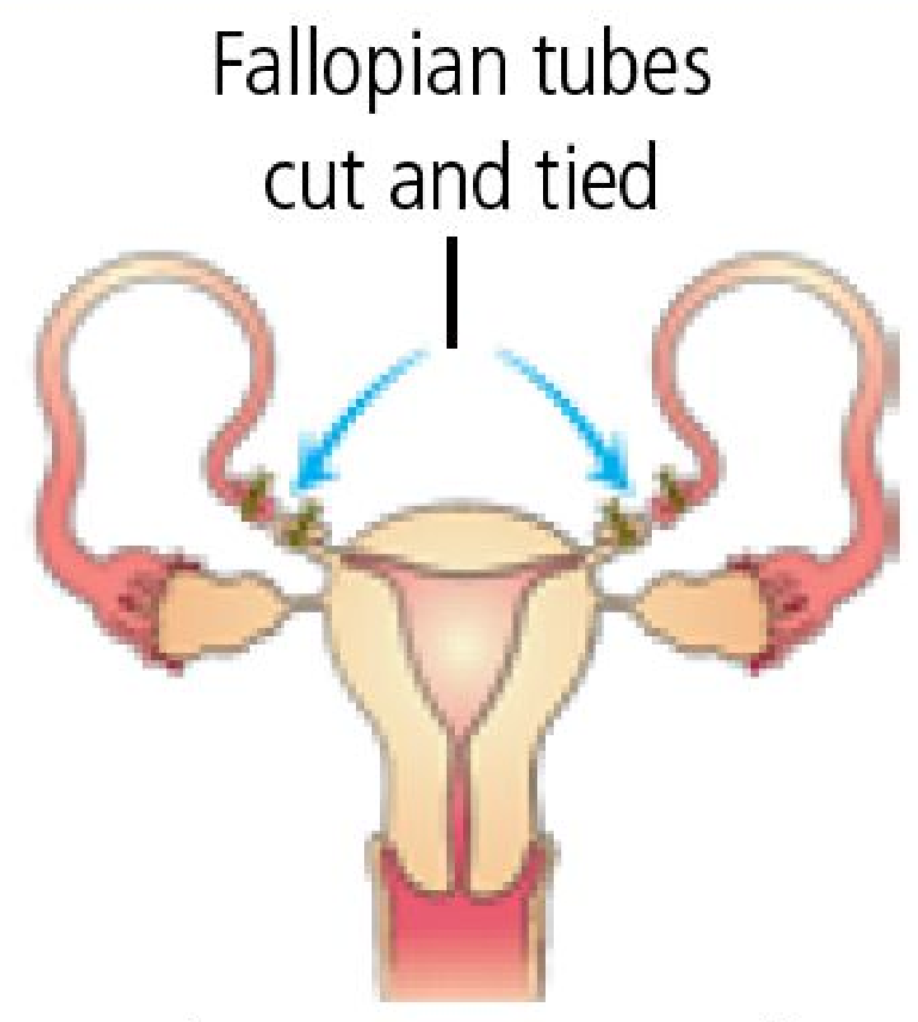
Oral contraceptive pills

Composition : Estrogen progestogen or progestogen alone. Inhibit ovulation and implantation as well as alter the quality of cervical mucus to prevent entry of sperms. *E.g.*, *Saheli*, (non-steroidal preparation/**once-a week pill**).

Surgical Methods

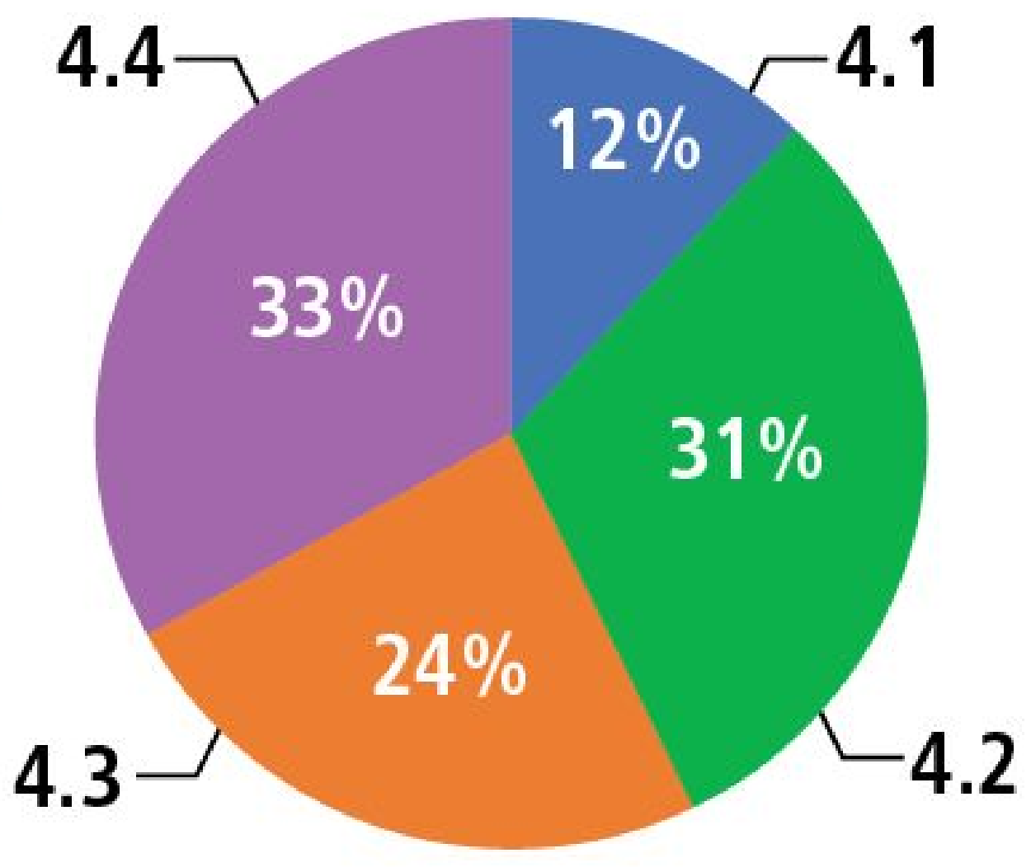


Vasectomy (Male)



Tubectomy (Female)

04 | Principles of Inheritance and Variation



Inheritance of Two Genes

The Law of Independent Assortment, proposed by Mendel, states that genes for different traits are inherited independently of each other, provided they are located on different chromosomes. During meiosis, homologous chromosomes carrying different genes are randomly distributed to gametes, ensuring that the inheritance of one gene does not affect the inheritance of another gene. This law applies to genes located on different chromosomes or genes that are far apart on the same chromosome. The law contributes to genetic diversity in offspring, as combinations of alleles for different traits can be inherited in numerous ways. Mendel's dihybrid cross experiment with pea plants, where he crossed plants with two different traits, such as seed colour and shape, supported this law, as he observed that the inheritance of one trait did not influence the inheritance of the other trait. However, the law does not apply to genes that are very close to each other on the same chromosome, as they may undergo genetic linkage and be inherited together. In a dihybrid cross, the typical phenotypic ratio in the F_2 generation is 9:3:3:1. The law helps explain the diversity of traits in organisms and is a cornerstone of Mendelian genetics.

Phenotypic ratio :

round yellow	round green	wrinkled yellow	wrinkled green
9	3	3	1

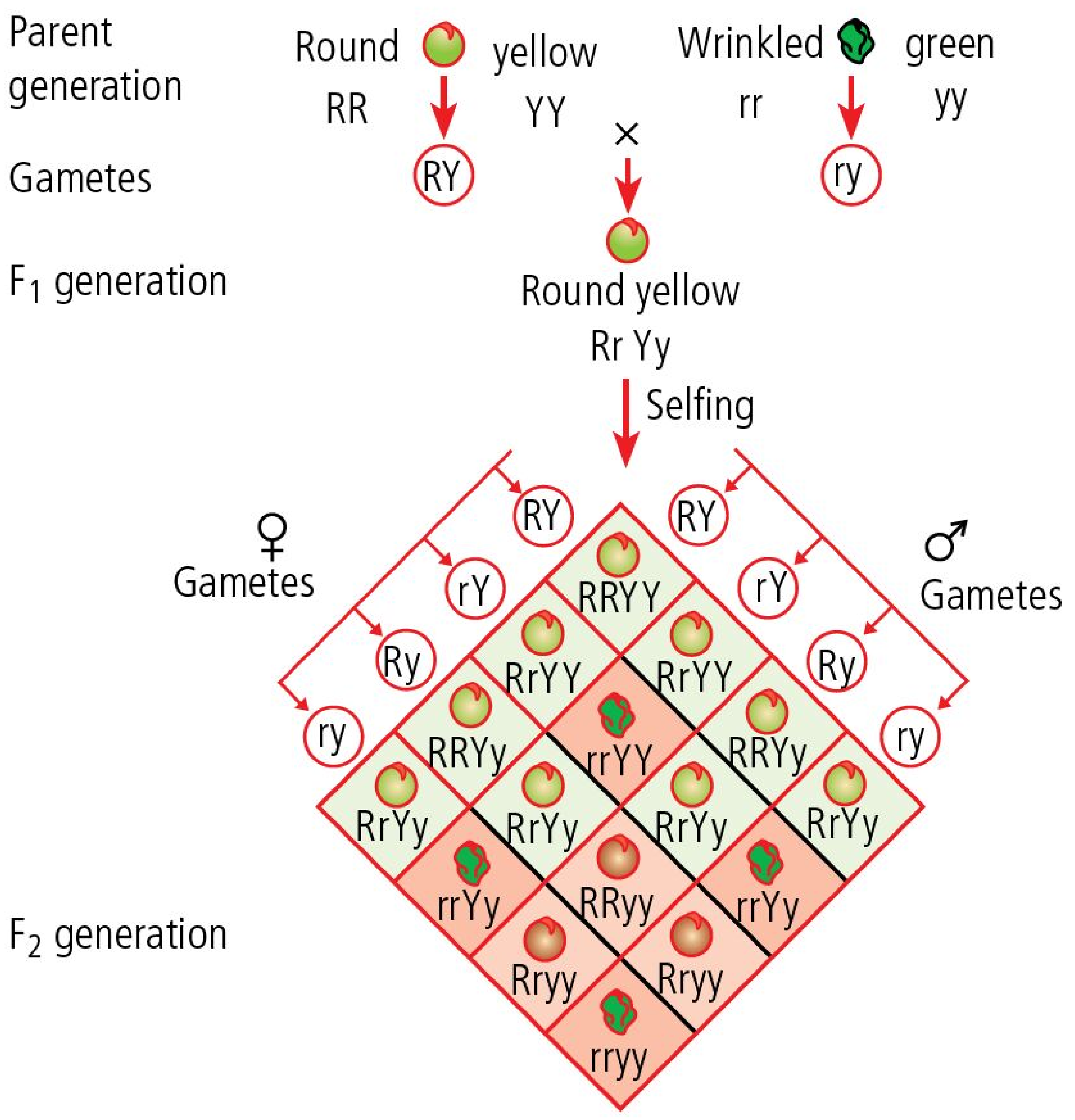
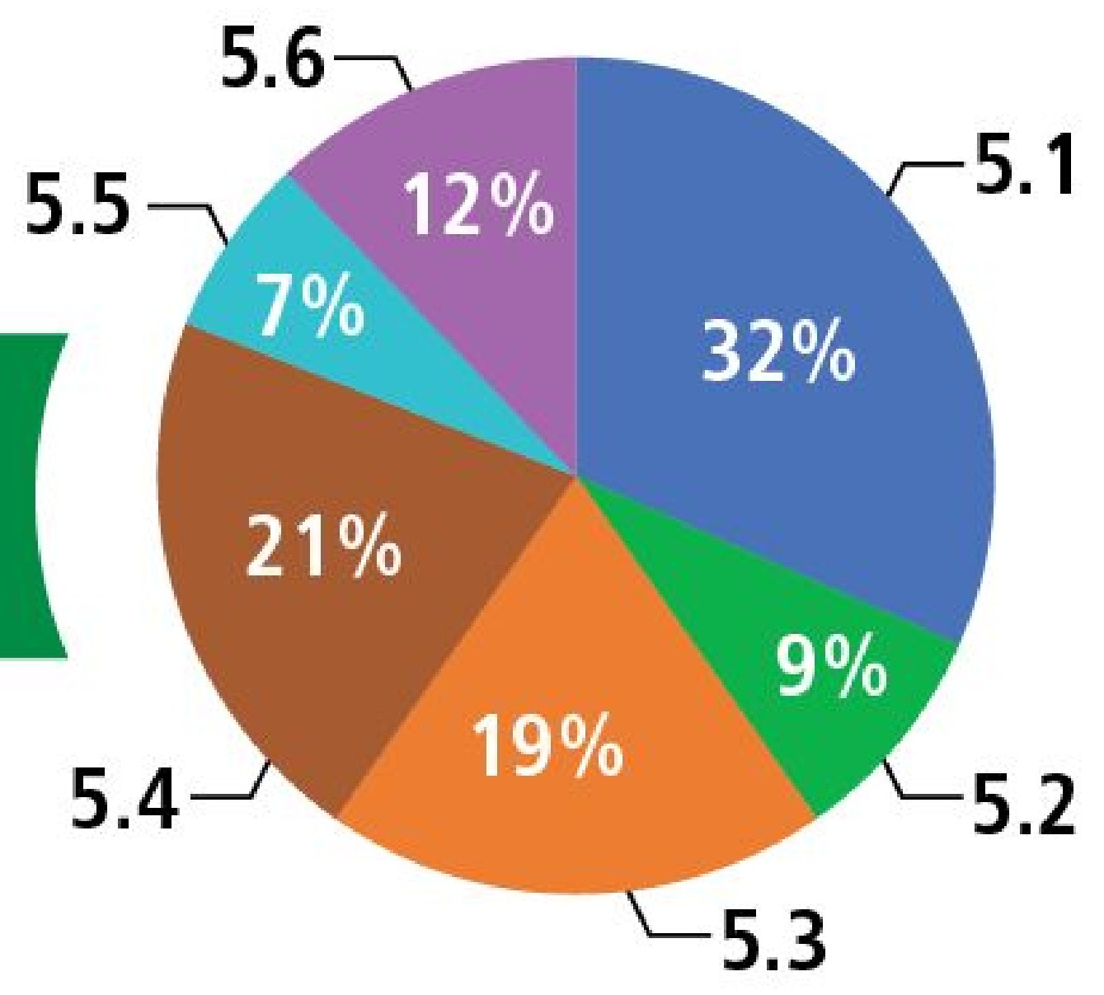
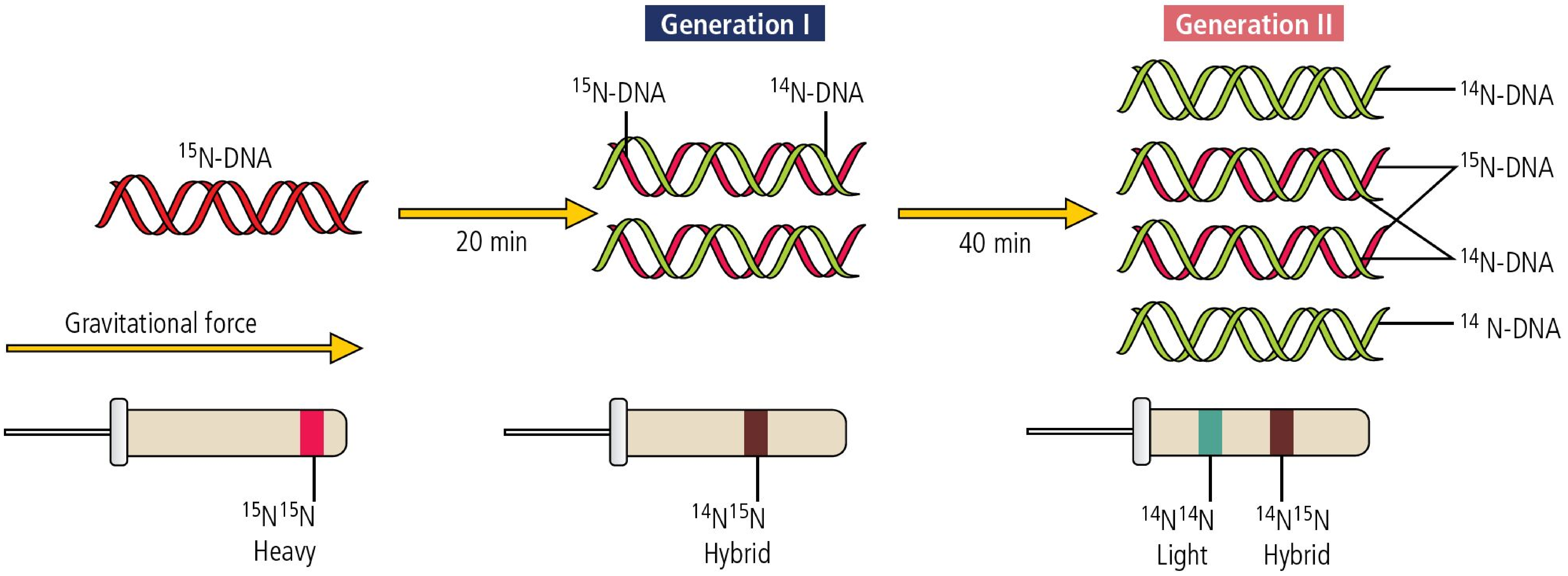


Fig.: Result of a dihybrid cross where the two parents differed in two pairs of contrasting traits : seed colour and seed shape

05 | Molecular Basis of Inheritance

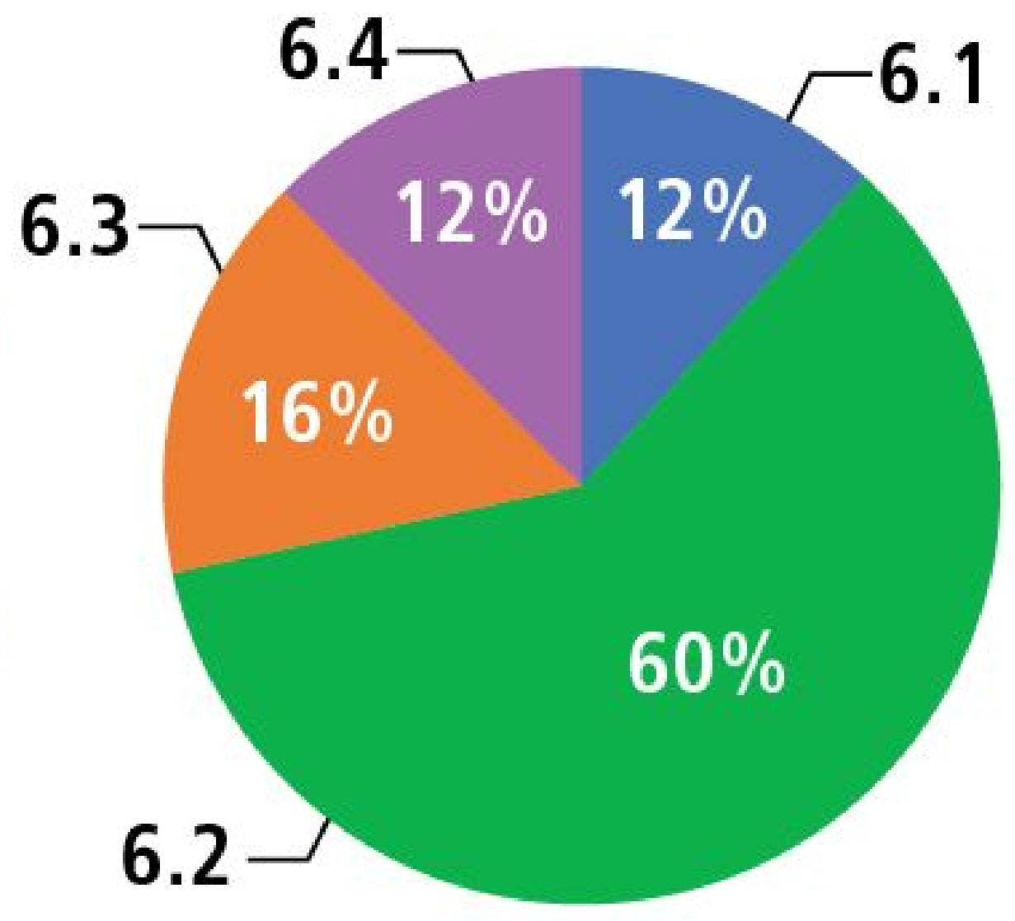


Meselson and Stahl's Experiment


Generation I
Generation II
^{15}N-DNA
^{15}N-DNA
^{14}N-DNA
^{14}N-DNA
^{15}N-DNA
^{14}N-DNA
^{14} N-DNA
20 min
40 min
Gravitational force
^{15}N^{15}N
Heavy
^{14}N^{15}N
Hybrid
^{14}N^{14}N
Light
^{14}N^{15}N
Hybrid

(Separation of DNA by Centrifugation)

06 | Evolution



What are the Evidences for Evolution?

Homologous Organs (Divergent Evolution)

Anatomically same structure but different functions.

Examples :

- Forelimbs of whales, bats, cheetah and humans
- Thorns and tendrils of *Bougainvillea* and *Cucurbita*
- Vertebrate hearts or brains

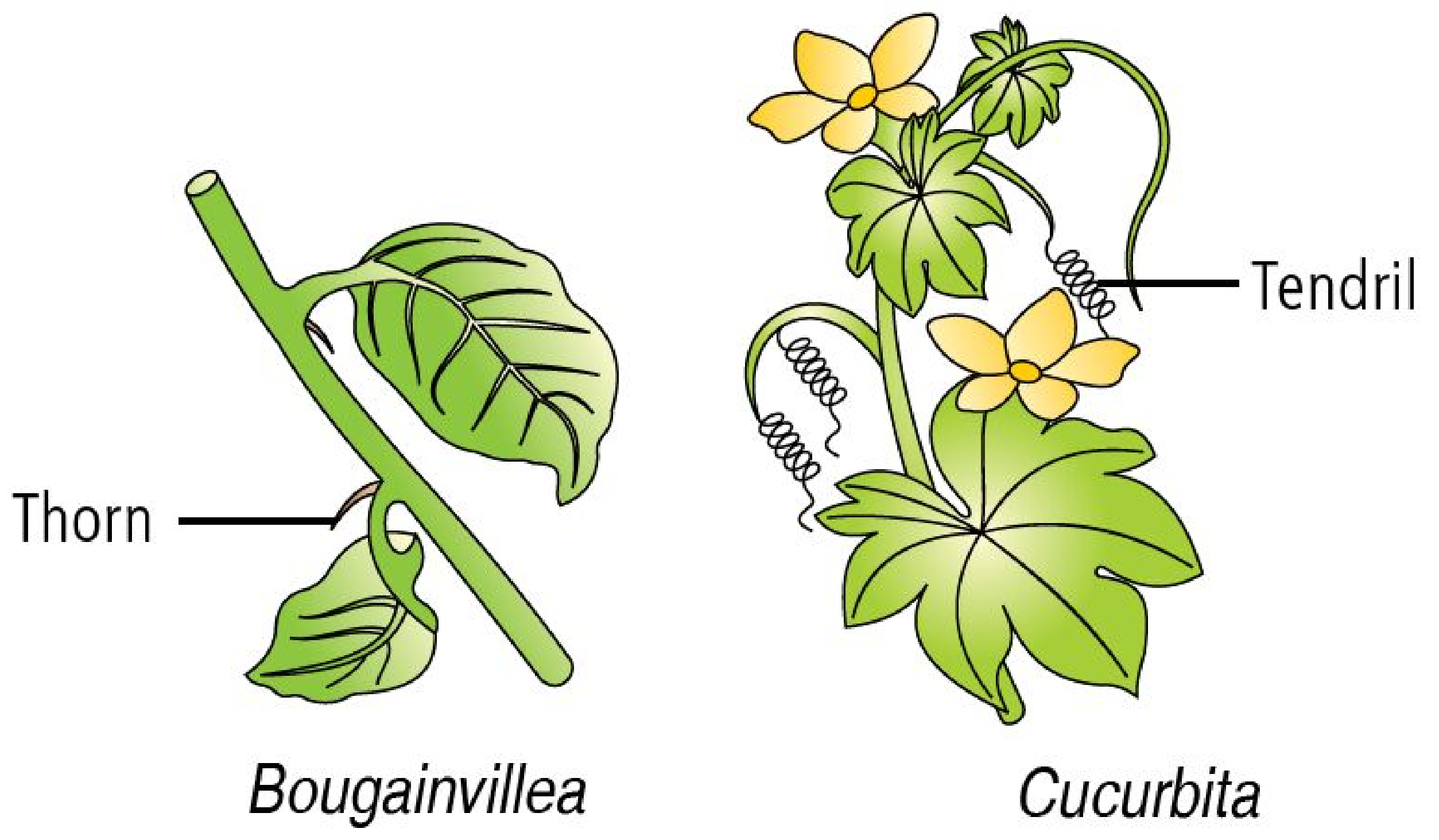

Tendril
Thorn
Bougainvillea
Cucurbita

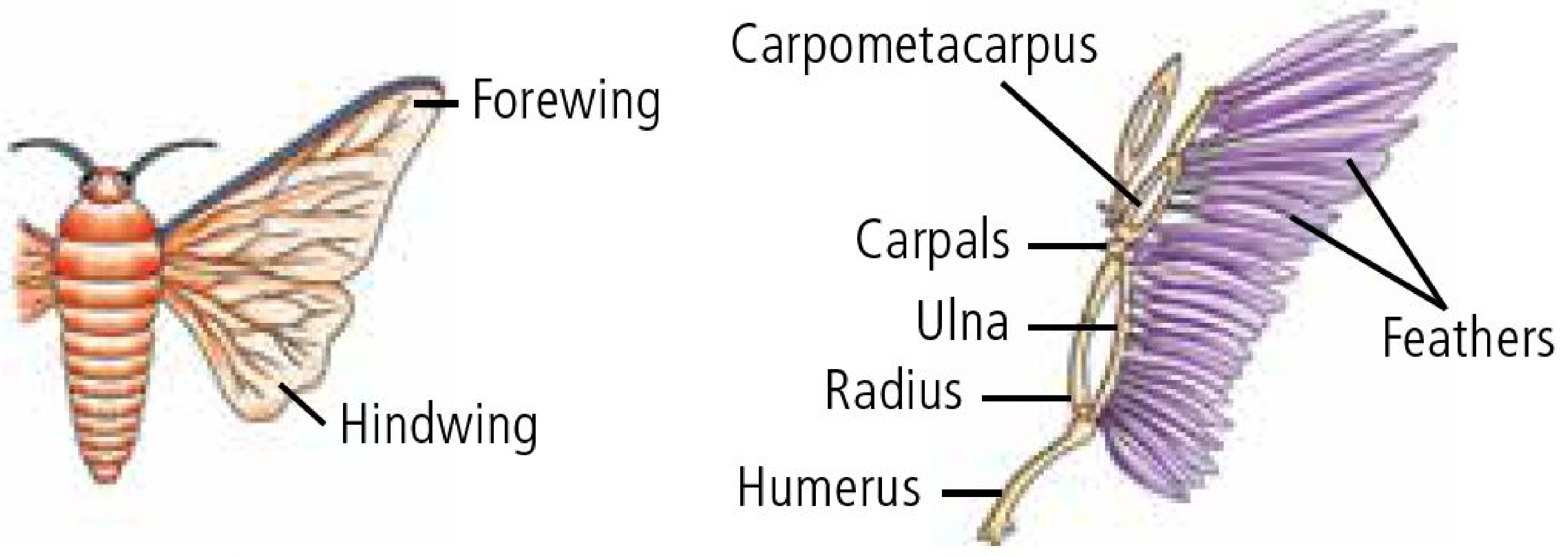
Fig.: Thorns of *Bougainvillea* are homologous to tendrils of *Cucurbita*

Analogous Organs (Convergent Evolution)

Anatomically different structures, same function.

Examples :

- Wings of an insect and birds
- Eyes of octopus and mammals
- Flippers of Penguins and Dolphins
- Sweet potato (root modification) and potato (stem modification)

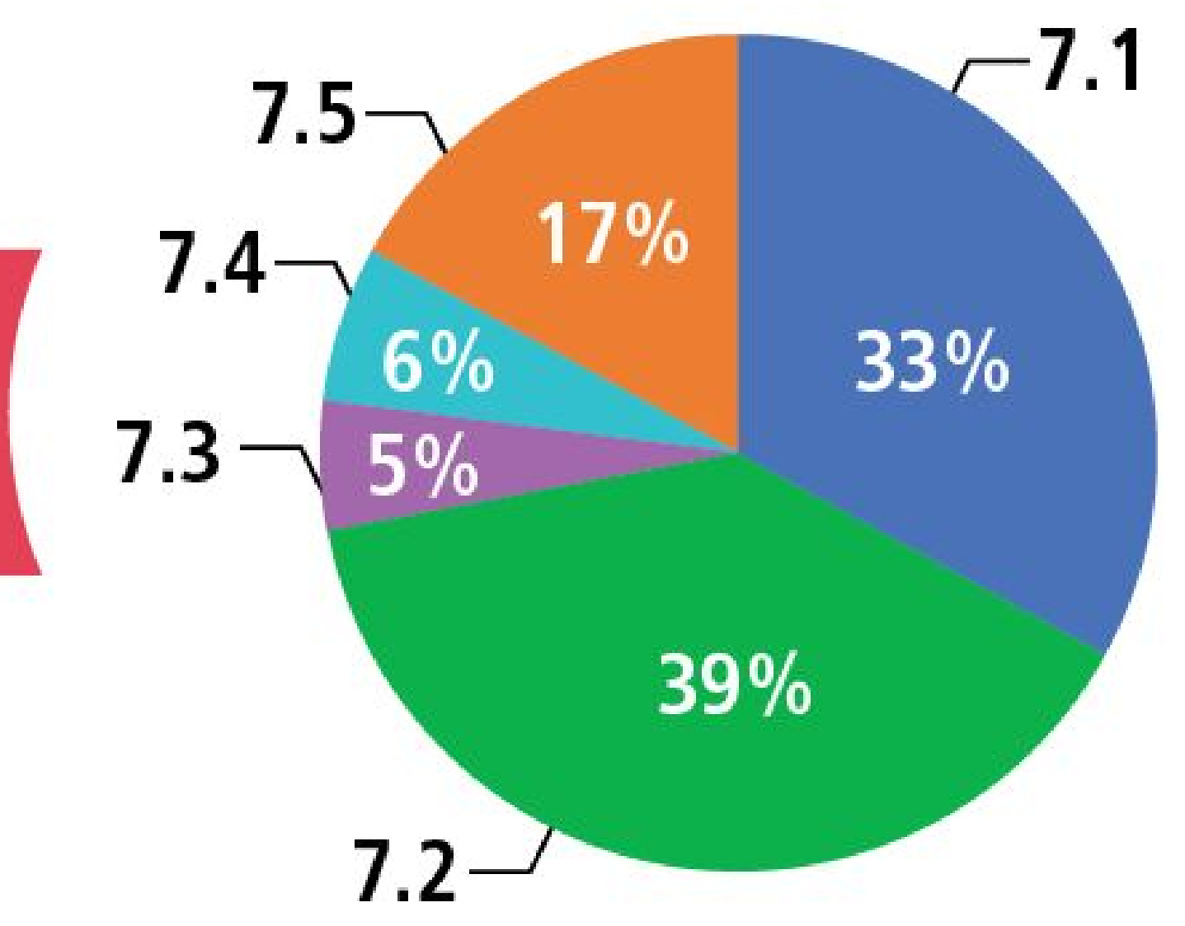

Forewing
Hindwing
Carpometacarpus
Carpals
Ulna
Radius
Humerus
Feathers

Insect wing **Bird wing**

Fig.: Wings of an insect are analogous to wings of bird

Evolution of Man *Dryopithecus* ➤ *Ramapithecus* ➤ *Australopithecus* ➤ *Homo habilis* (650-800 cc) ➤ *Homo erectus* (900 cc) ➤ *Neanderthal* man (1400 cc) ➤ *Homo sapiens*

07 | Human Health and Disease



Common Diseases in Humans

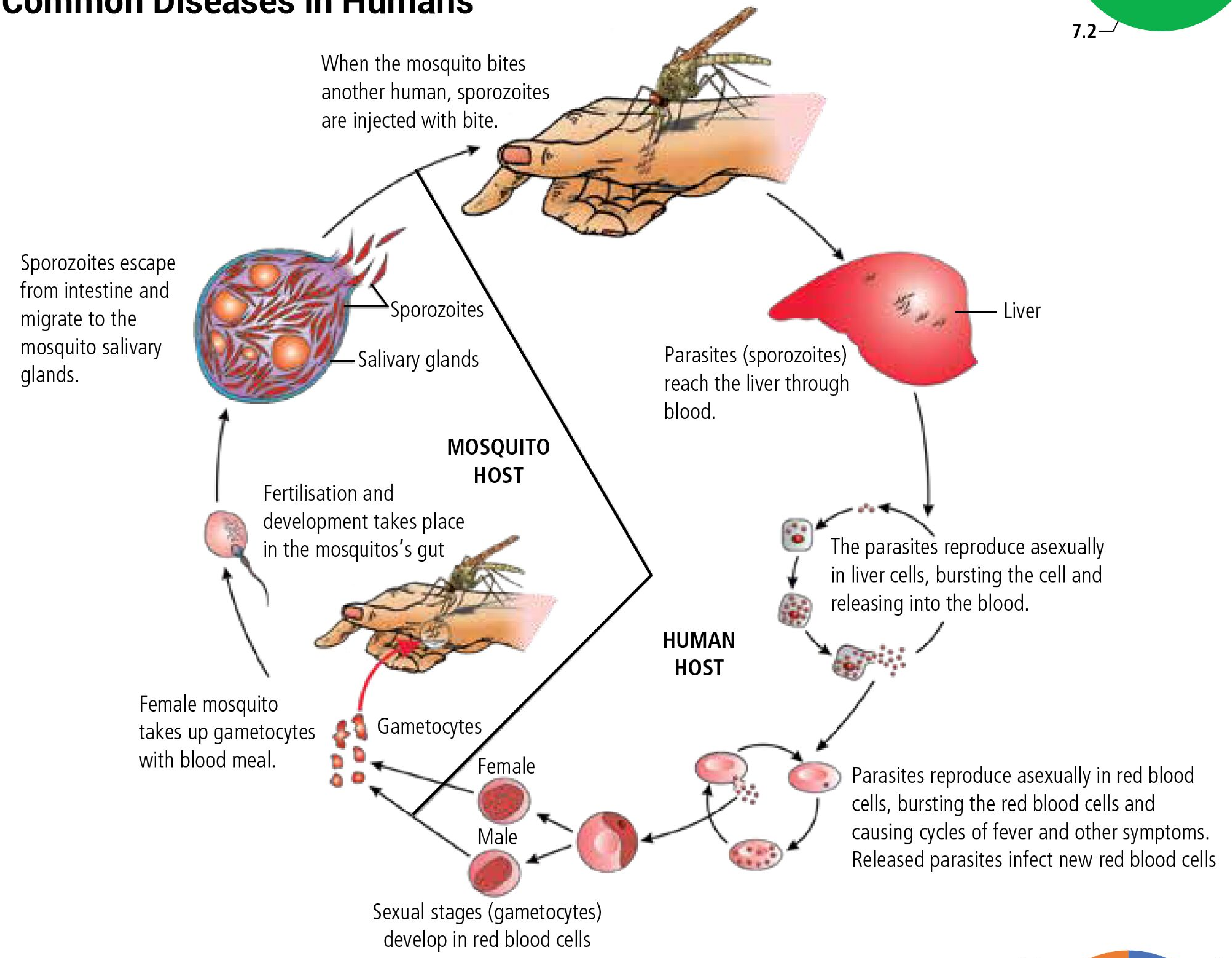
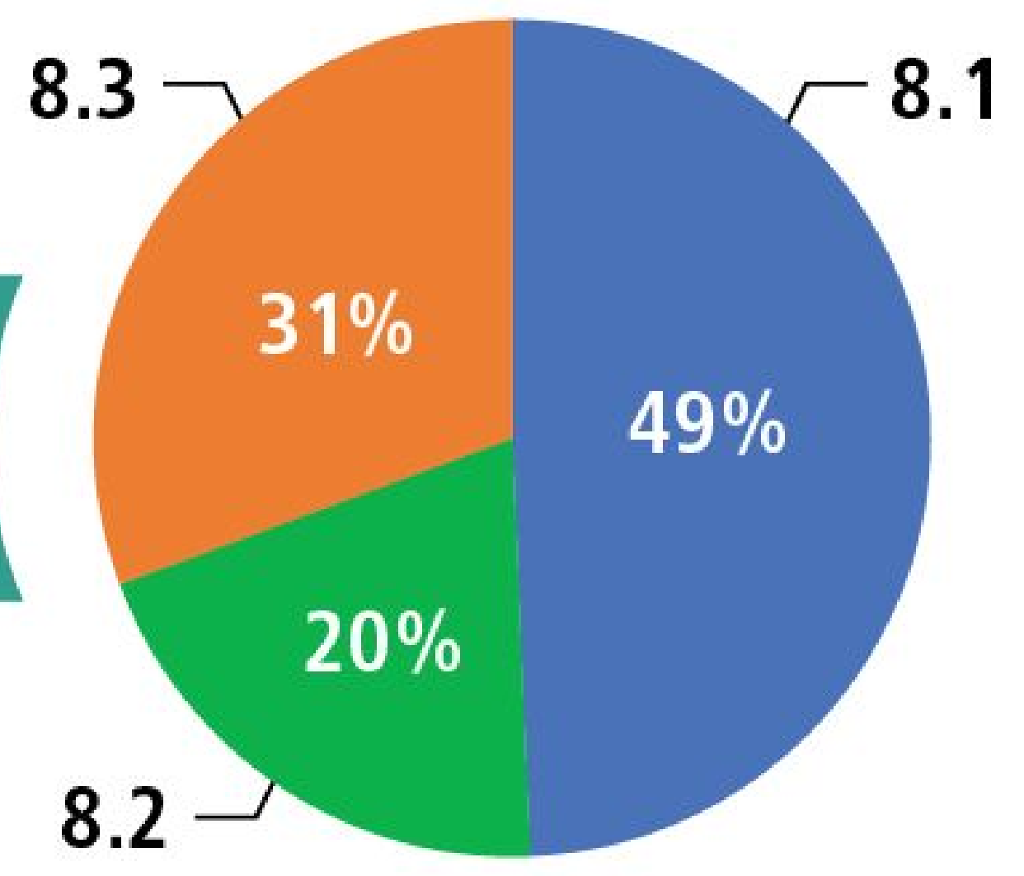

When the mosquito bites another human, sporozoites are injected with bite.
Liver
Parasites (sporozoites) reach the liver through blood.
The parasites reproduce asexually in liver cells, bursting the cell and releasing into the blood.
HUMAN HOST
Parasites reproduce asexually in red blood cells, bursting the red blood cells and causing cycles of fever and other symptoms. Released parasites infect new red blood cells
Sexual stages (gametocytes) develop in red blood cells
Female
Male
Gametocytes
Female mosquito takes up gametocytes with blood meal.
Fertilisation and development takes place in the mosquitos's gut
MOSQUITO HOST
Sporozoites escape from intestine and migrate to the mosquito salivary glands.
Sporozoites
Salivary glands

Fig.: Stages in the life cycle of *Plasmodium*

08 | Microbes in Human Welfare



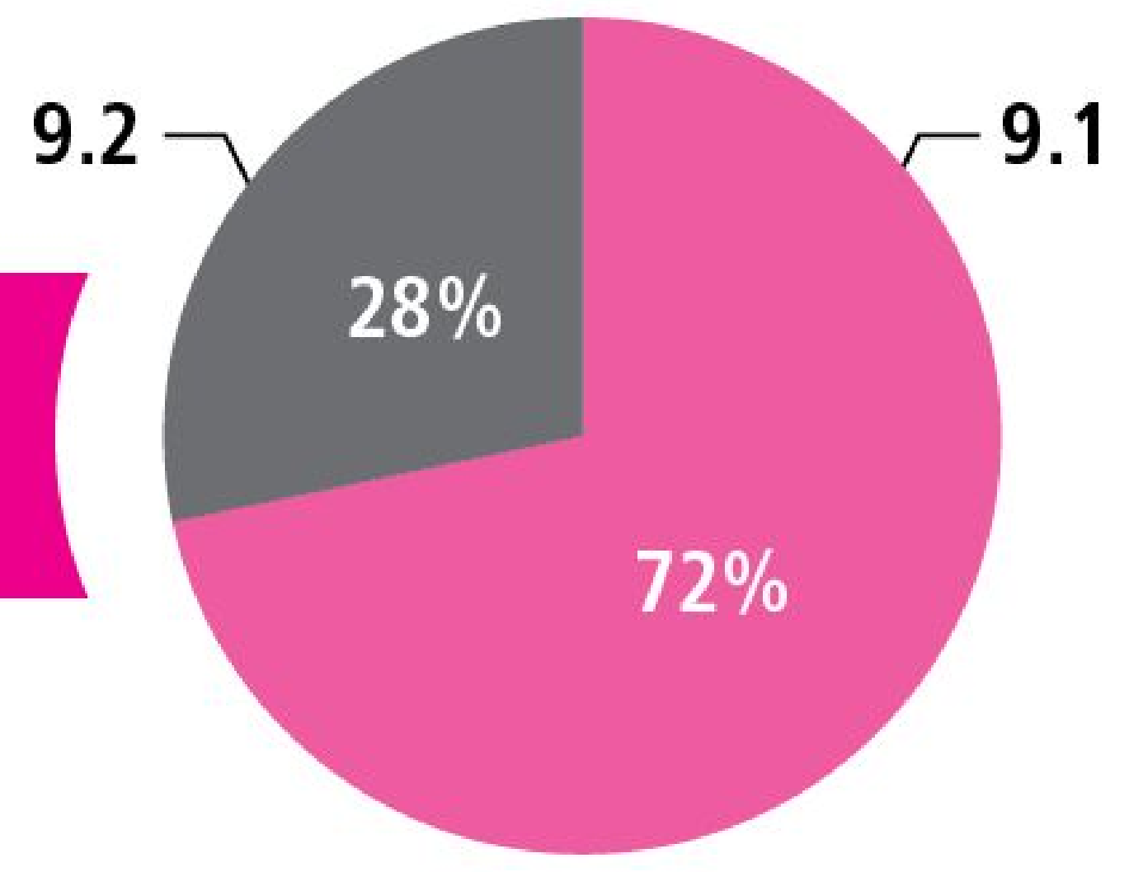
Microbes in Industrial Products

Micro-organisms	Products
Penicillium notatum (Fungus)	Penicillin
Aspergillus niger (Fungus)	Citric acid
Acetobacter aceti (Bacterium)	Acetic acid
Streptococcus (Bacterium)	Streptokinase (Clot bluster)
Lactobacillus (Bacterium)	Lactic acid
Clostridium butylicum (Bacterium)	Butyric acid
Trichoderma polysporum (Fungus)	Cyclosporin A (Organ transplantation)
Monascus purpureus (Yeast)	Statins (Blood-cholesterol lowering agent)

Saccharomyces cerevisiae

Product : Alcohol

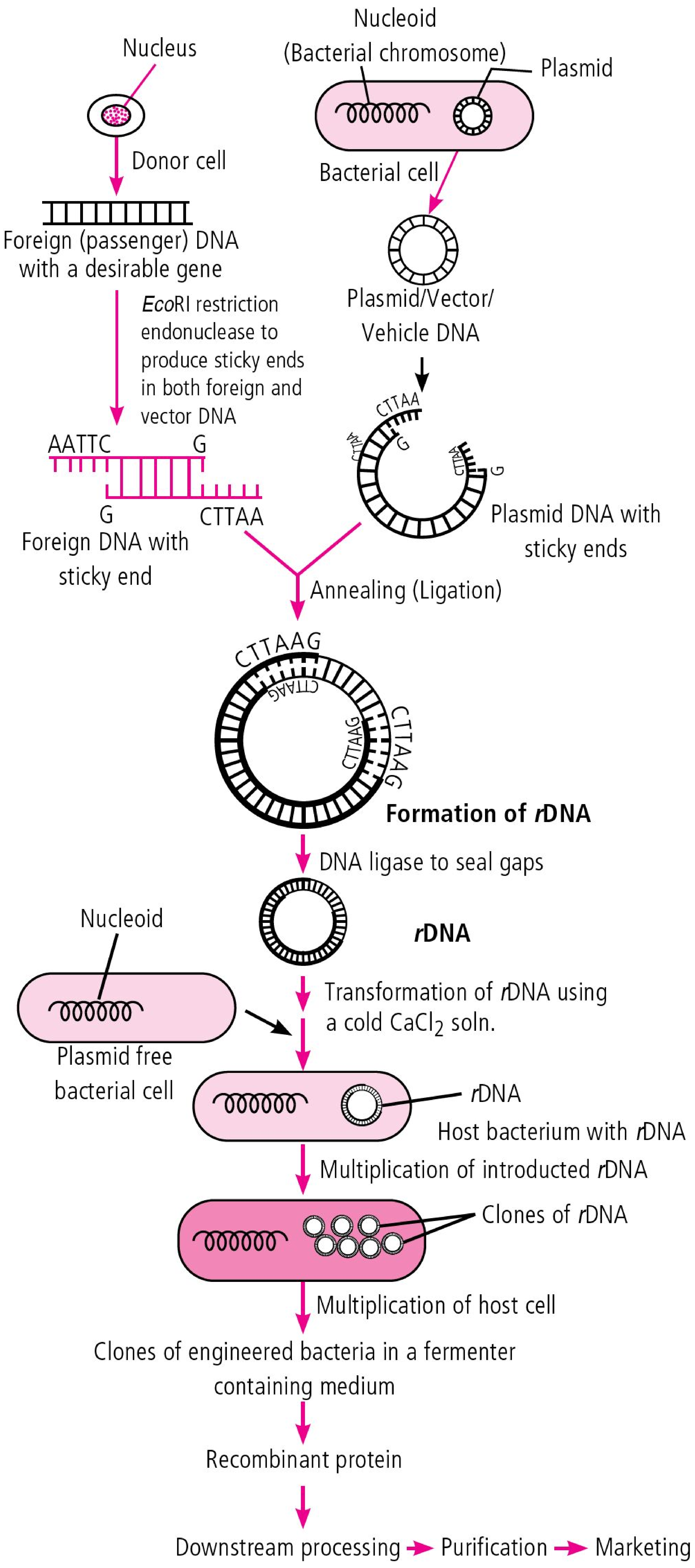
1. Without distillation : Wine and beer
2. Distillation of : Whisky, brandy fermented broth and rum



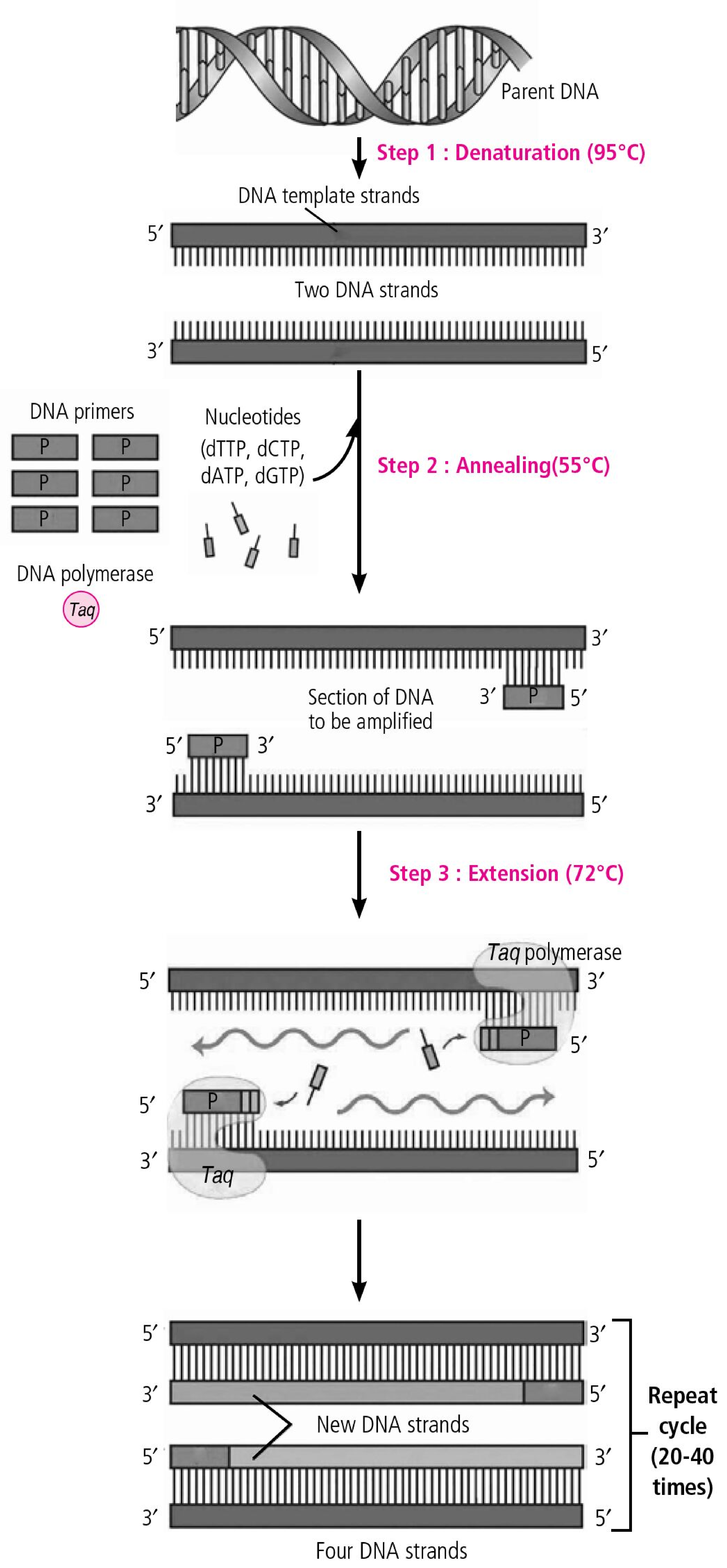
09 | Biotechnology : Principles and Processes

Processes of Recombinant DNA Technology

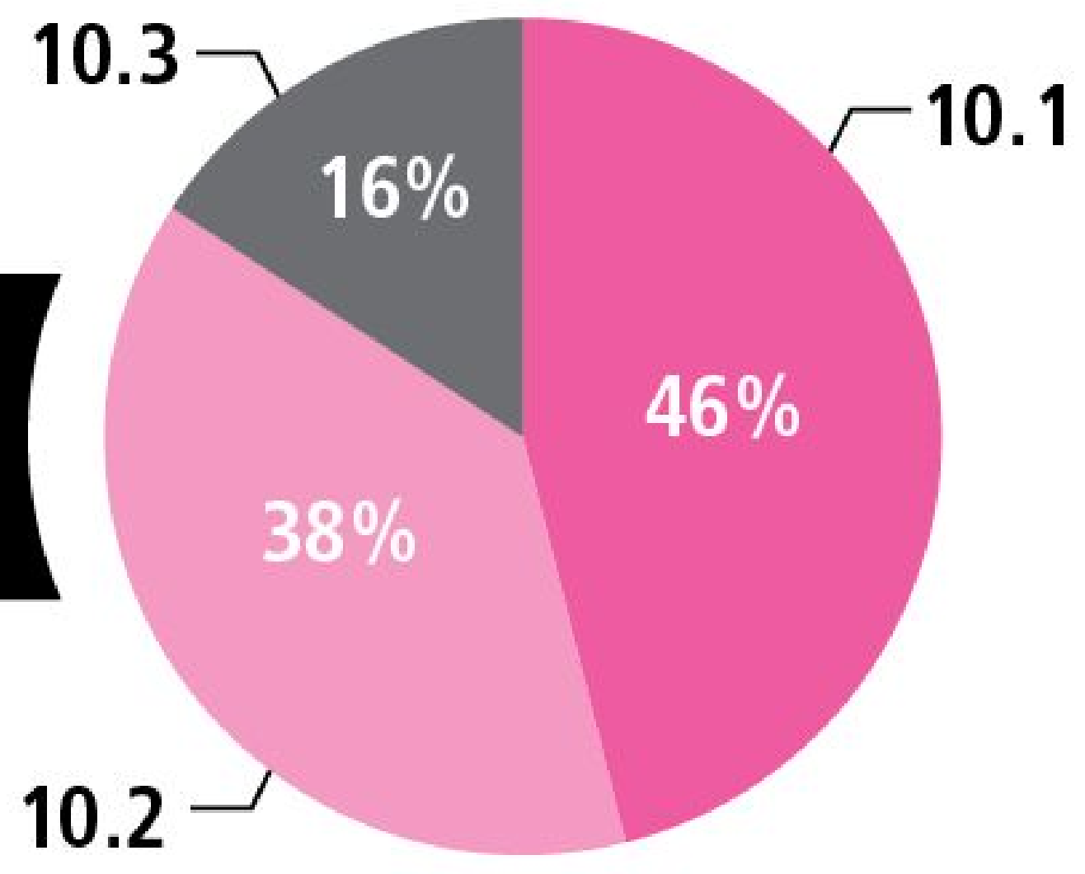
Steps involved in recombinant DNA technology


Nucleus
Donor cell
Foreign (passenger) DNA with a desirable gene
EcoRI restriction endonuclease to produce sticky ends in both foreign and vector DNA
AATTC
G
G
CTTAA
Foreign DNA with sticky end
Nucleoid (Bacterial chromosome)
Plasmid
Bacterial cell
Plasmid/Vector/ Vehicle DNA
CTTAA
G
Plasmid DNA with sticky ends
Annealing (Ligation)
CTTAAG
Formation of rDNA
DNA ligase to seal gaps
rDNA
Nucleoid
Plasmid free bacterial cell
Transformation of rDNA using a cold CaCl2 soln.
rDNA
Host bacterium with rDNA
Multiplication of introducted rDNA
Clones of rDNA
Multiplication of host cell
Clones of engineered bacteria in a fermenter containing medium
Recombinant protein
Downstream processing
Purification
Marketing

Polymerase chain reaction


Parent DNA
Step 1 : Denaturation (95°C)
DNA template strands
5′
3′
Two DNA strands
3′
5′
DNA primers
P
Nucleotides (dTTP, dCTP, dATP, dGTP)
DNA polymerase
Taq
Step 2 : Annealing(55°C)
Section of DNA to be amplified
Step 3 : Extension (72°C)
Taq polymerase
Taq
New DNA strands
Repeat cycle (20-40 times)
Four DNA strands

10 | Biotechnology and its Applications



Biotechnology Applications in Agriculture

Plant Tissue Culture

Plant tissue culture is the technique of maintaining and growing plant cells, tissues or organs, especially on an artificially sterilised nutrient medium, under controlled environmental conditions.

- Proteins produced by *Bt* kill lepidopterans (tobacco budworm, armyworm), coleopterans (beetles) and dipterans (flies, mosquitoes).
- *cry IAc* and *cry IIAb* control cotton bollworms.
- *cry IAb* control corn borer.

Transgenic Animals

Animals that have had their DNA manipulated to possess and express an extra (foreign) gene are known as transgenic animals. Transgenic rats, rabbits, pigs, sheep, cows and fish have been produced, although over 95 per cent of all existing transgenic animals are mice, benefit from such modifications are:-

Normal physiology and development

Transgenic animals can be specifically designed to allow the study of how genes are regulated, and how they affect the normal functions of the body and its development, e.g., study of complex factors involved in growth such as insulin-like growth factor.

Biological products

Medicines required to treat certain human diseases can contain biological products, but such products are often expensive to make. Transgenic animals that produce useful biological products can be created by the introduction of the portion of DNA (or genes) which codes for a particular product such as human protein (α-1-antitrypsin) used to treat emphysema. Similar attempts are being made for treatment of phenylketonuria (PKU) and cystic fibrosis. In 1997, the first transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre).

Study of disease

Many transgenic animals are designed to increase our understanding of how genes contribute to the development of disease. These are specially made to serve as models for human diseases so that investigation of new treatments for diseases is made possible. Today transgenic models exist for many human diseases such as cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's.

Vaccine safety

Transgenic mice are being developed for use in testing the safety of vaccines before they are used on humans. Transgenic mice are being used to test the safety of the polio vaccine. If successful and found to be reliable, they could replace the use of monkeys to test the safety of batches of the vaccine.

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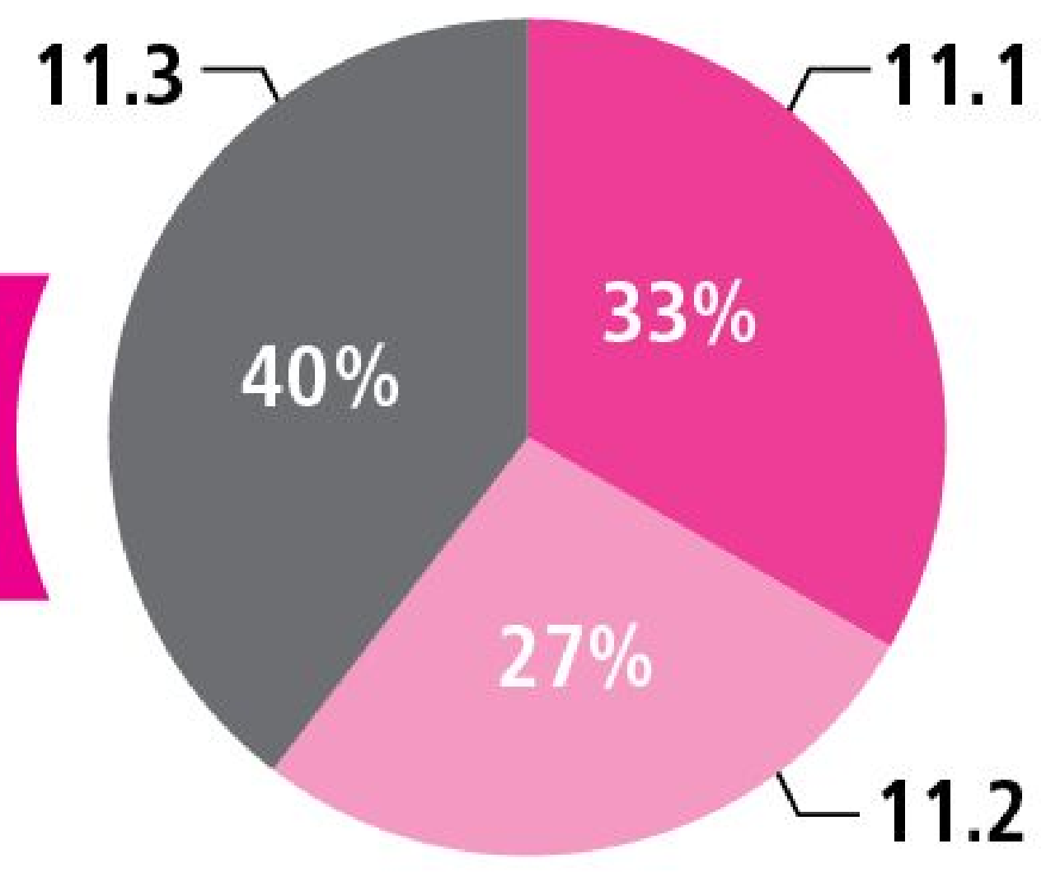
11 | Organisms and Populations



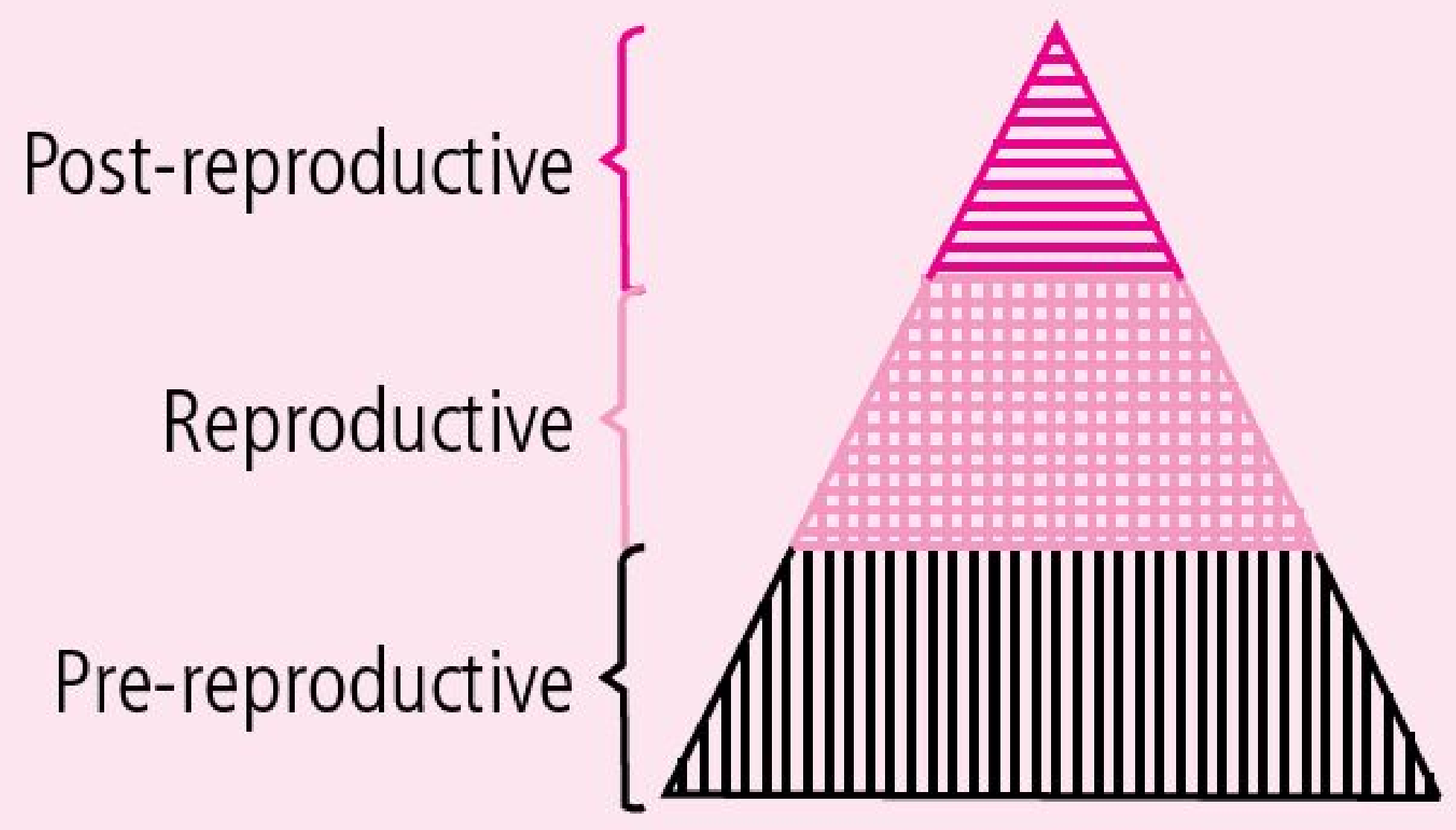
Populations

Population Attributes

A population at any given time is composed of individuals of different ages. When the age distribution (per cent individuals of a given age or age group) is plotted for the population, the resulting structure is called an **age pyramid**.

Various types of age pyramid

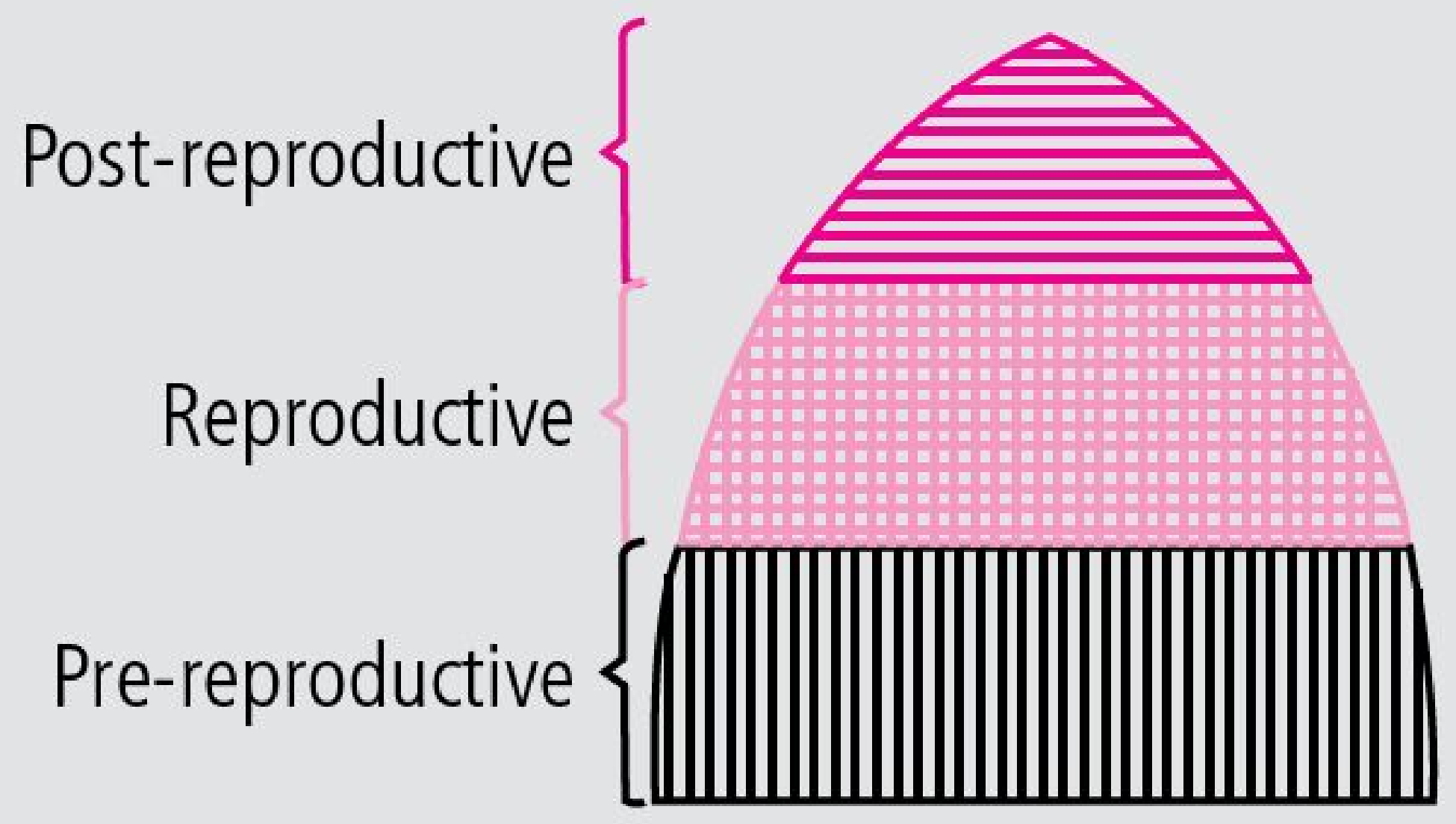
Triangular Age Pyramid


Post-reproductive
Reproductive
Pre-reproductive

Expanding population

The number of pre-reproductive individuals is very large, number of reproductive individuals is moderate while post-reproductive individuals are fewer.

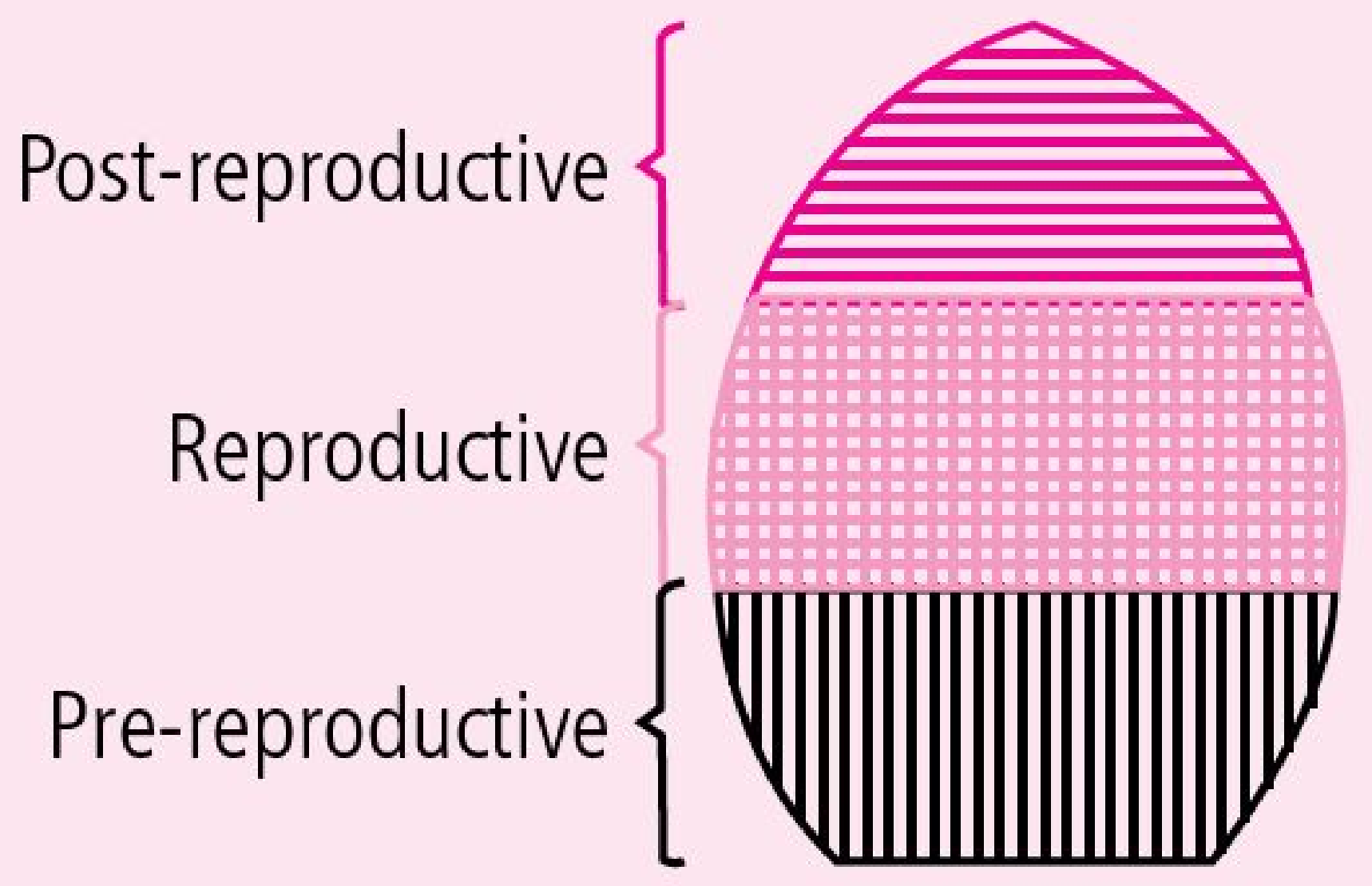
Bell Shaped Age Pyramid


Post-reproductive
Reproductive
Pre-reproductive

Stable population

The number of pre-reproductive and reproductive individuals is almost equal. Post-reproductive individuals are comparatively fewer.

Urn-Shaped Age Pyramid

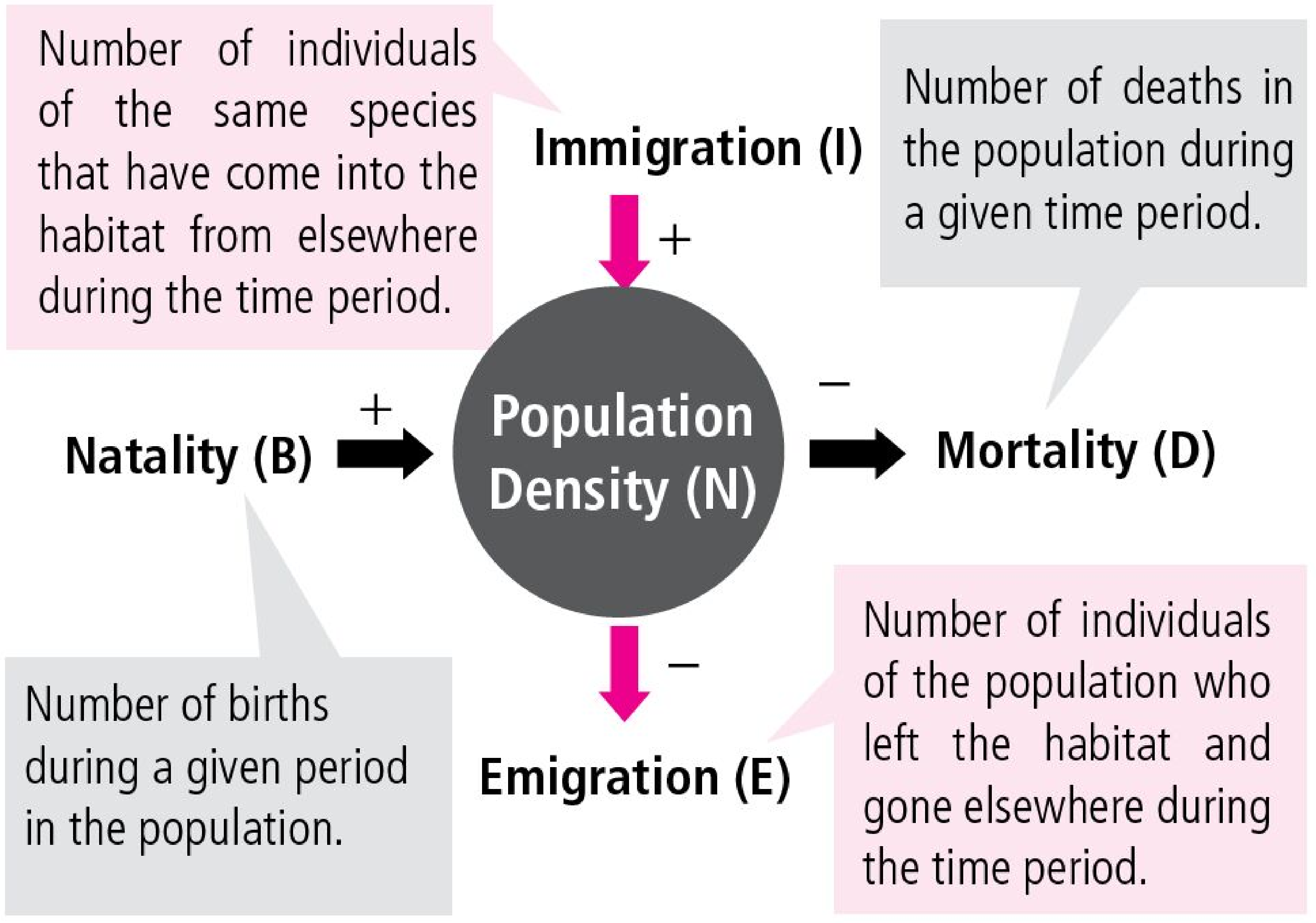

Post-reproductive
Reproductive
Pre-reproductive

Declining population

Proportion of reproductive age group is higher than the individuals in pre-reproductive age group. Number of post-reproductive individuals is also sizeable.

Population Growth

Population density : Number of individuals of species per unit area or per unit volume at given time.


Immigration (I)
+
Natality (B)
+
Population Density (N)
–
Mortality (D)
–
Emigration (E)

Number of individuals of the same species that have come into the habitat from elsewhere during the time period.

Number of deaths in the population during a given time period.

Number of births during a given period in the population.

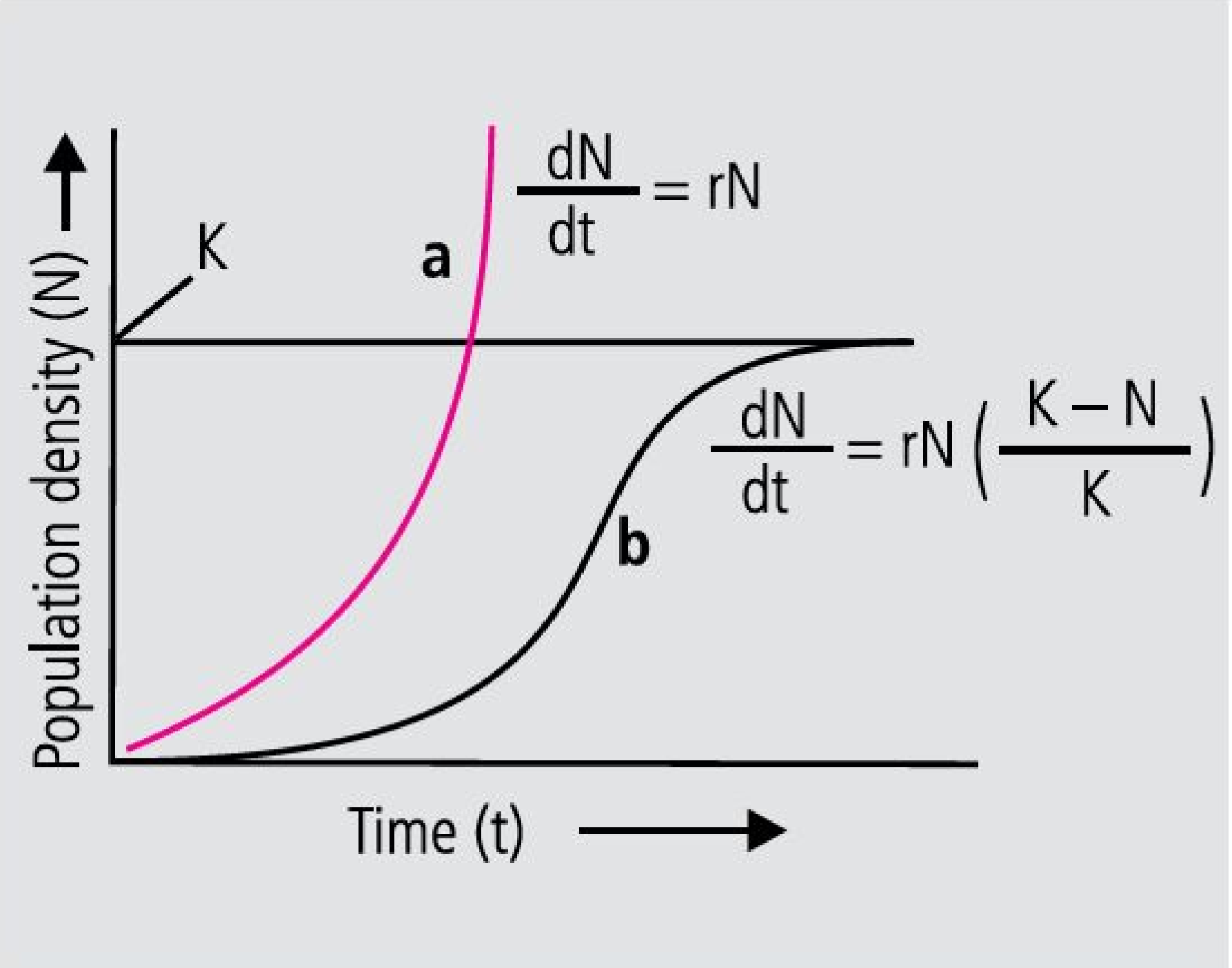
Number of individuals of the population who left the habitat and gone elsewhere during the time period.

Population density at time t + 1, $N_{t+1} = N_t + [(B + I) - (D + E)]$

If $(B + I) > (D + E)$, then population density will increase

Growth Curve

- Population growth curve '**a**' when resources are not limiting the growth, plot is exponential.
- Population growth curve '**b**' when resources are limiting the growth, plot is logistic, K is carrying capacity, r = intrinsic rate of natural increase

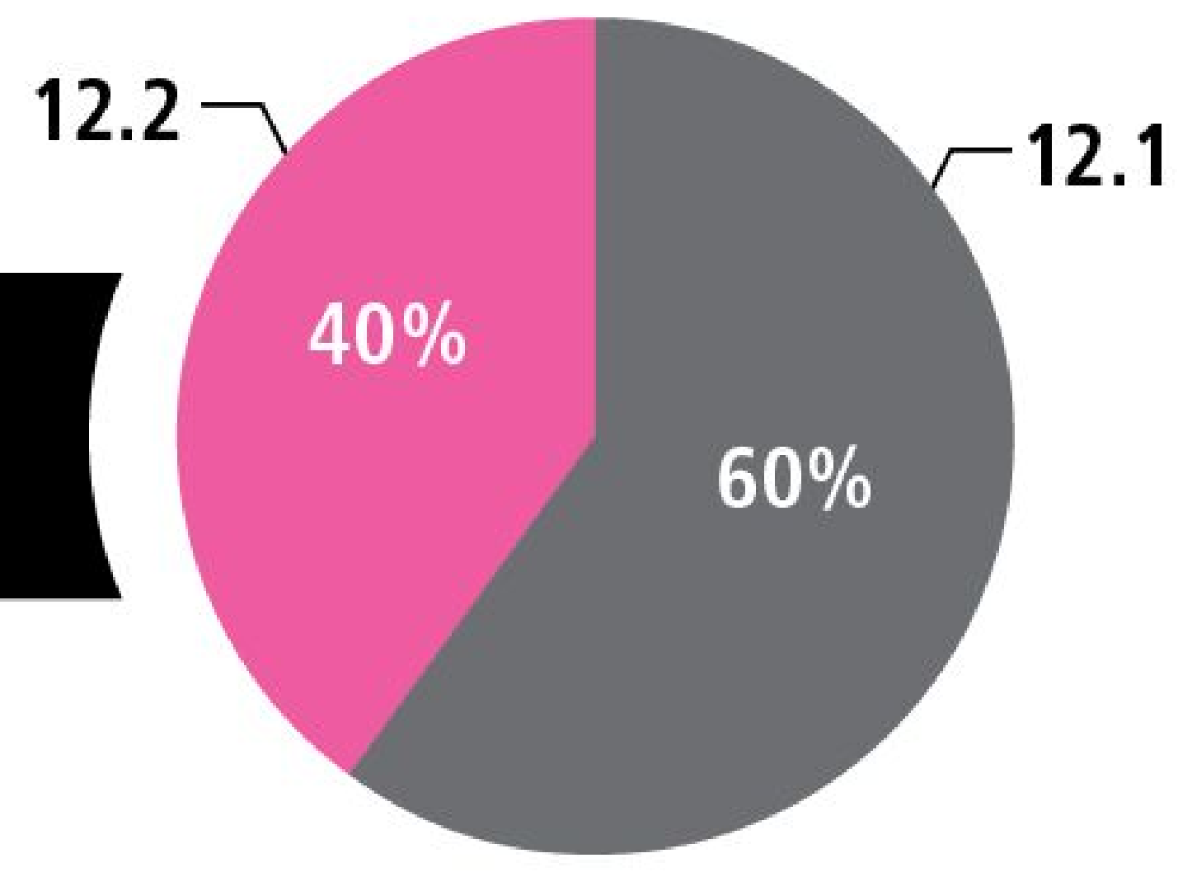


Population Interactions

Positive interactions Mutualism (+, +); Commensalism (+,0)

Negative interactions Amensalism (-,0); Competition (-, -); Parasitism/Predation (+, -)

12 | Ecosystem



Productivity

Rate of formation of biomass per unit area over a period of time.

Units : $gm^{-2}\ yr^{-1}$ or K cal $m^{-2}\ yr^{-1}$

Primary production : Amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.

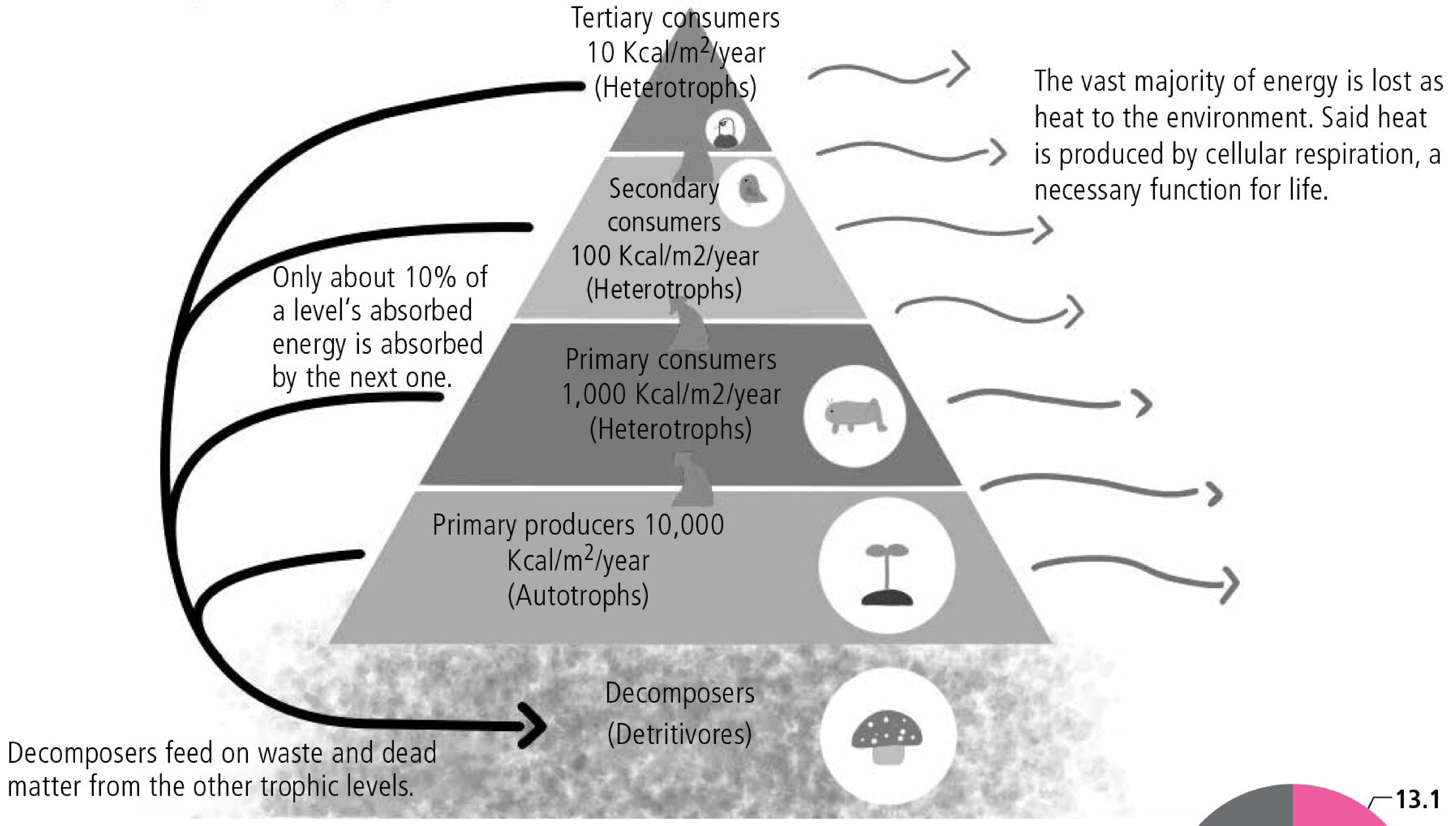
Gross primary productivity : Rate of production of organic matter during photosynthesis.

Net primary productivity : Available biomass for consumption to heterotrophs (herbivores and decomposers).

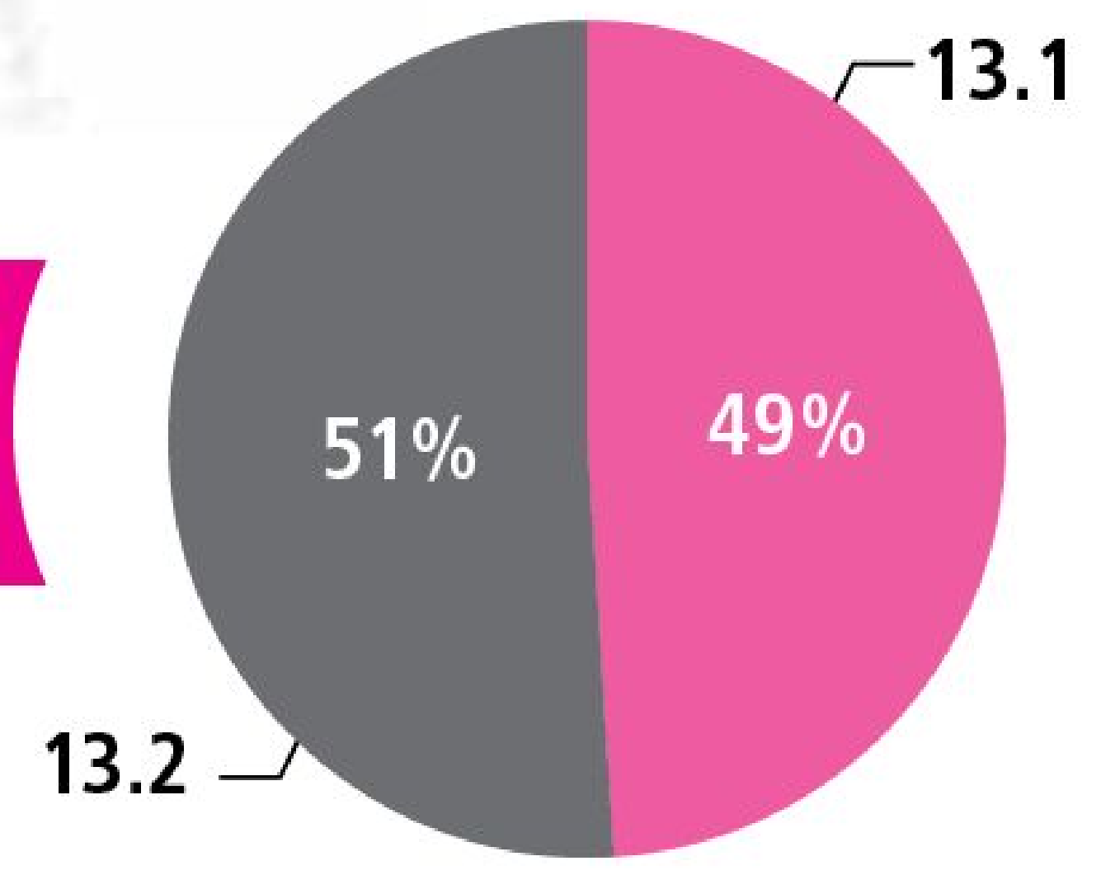
Net Primary Productivity (NPP) = Gross Primary Productivity (GPP) – Respiration losses (R)

Secondary productivity : Rate of formation of new organic matter by consumers.

Trophic Levels and Energy Flow


Tertiary consumers
10 Kcal/m^2/year
(Heterotrophs)
Secondary consumers
100 Kcal/m2/year
(Heterotrophs)
Primary consumers
1,000 Kcal/m2/year
(Heterotrophs)
Primary producers 10,000
Kcal/m^2/year
(Autotrophs)
Decomposers
(Detritivores)
Only about 10% of a level's absorbed energy is absorbed by the next one.
The vast majority of energy is lost as heat to the environment. Said heat is produced by cellular respiration, a necessary function for life.
Decomposers feed on waste and dead matter from the other trophic levels.

13 | Biodiversity and Conservation



Biodiversity

Biodiversity is the term popularised by the sociobiologist Edward Wilson to describe the combined diversity at all the levels of biological organisation

Types of Diversity

Genetic diversity	Species diversity	Ecological diversity
Rauwolfia vomitoria growing in different Himalayan ranges shows genetic variation in terms of potency and reserpine concentration.	More number of amphibian species are present in Western Ghats than the Eastern Ghats.	India with its rainforest, mangroves, alpine meadows, etc., has greater ecosystem diversity than Scandinavian country like Norway.

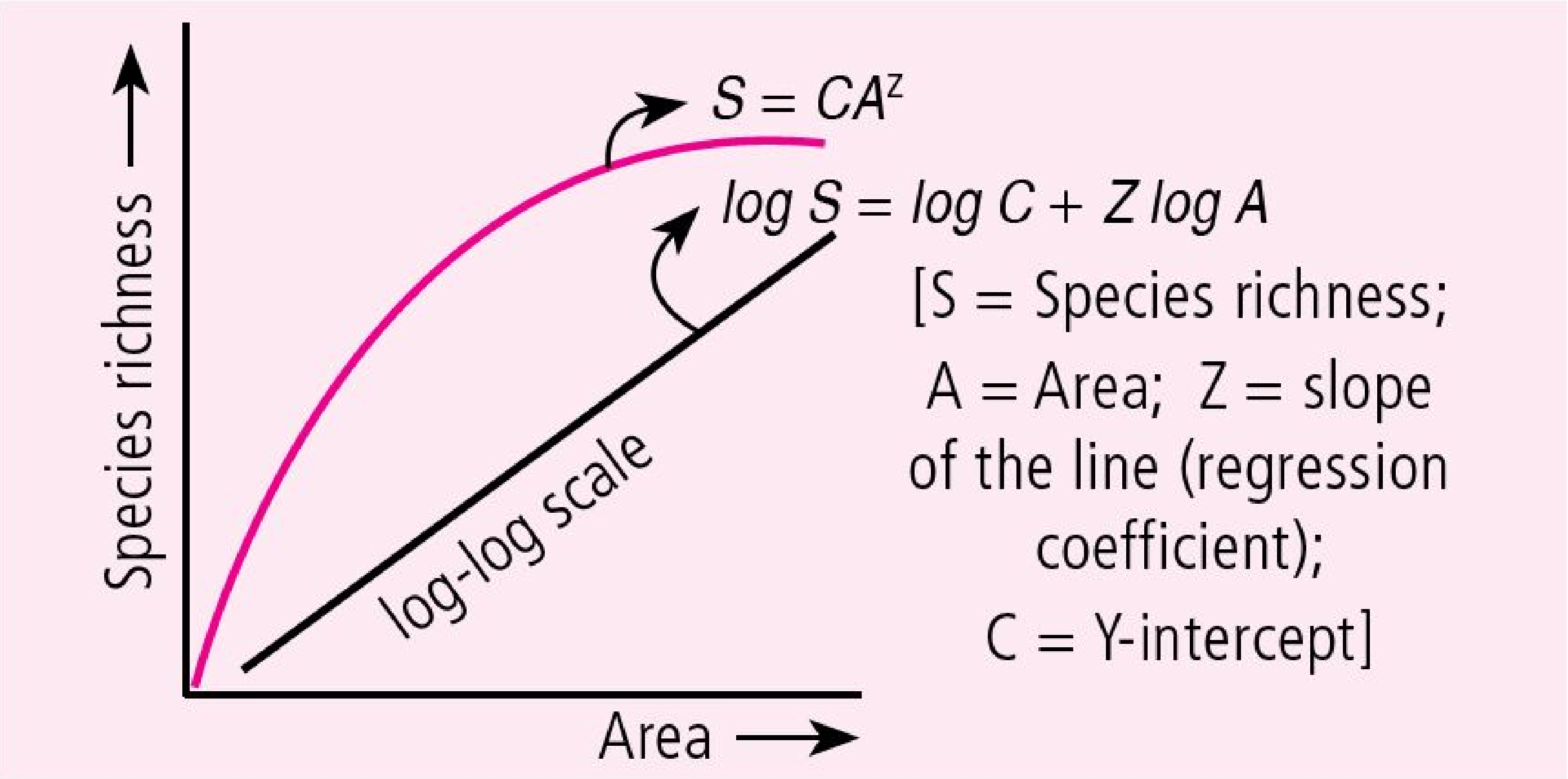
Causes of Biodiversity Loss (The Evil Quartet)

Habitat Loss and fragmentation	Over-exploitation	Alien Species invasion	Co-extinction
Cutting of Amazon rainforest	Dodo, Passenger pigeon Steller's sea cow got extinct.	*Eichhornia*, *Parthenium* Nile perch, *Clarias gariepinus*	Coevolved plant-pollinator mutualism

Species-Area Relationship

The relationship between species richness and area turned out to be a rectangular hyperbola for a wide variety of taxa.

- Value of Z generally lies in the range of 0.1 to 0.2.
- In large areas like entire continents, the value of Z lies in range of 0.6 – 1.2.
- Z is 1.15 for frugivorous birds and mammals in tropical forests of different continents.



Biodiversity Conservation

- **Conservation Strategies**
  - *In-situ*
    - Hotspots
    - Protected areas
      - Wildlife Sanctuaries
      - Biosphere reserves
      - National parks
  - *Ex-situ*
    - Seed banks, gene banks, tissue culture
    - Botanical gardens, Zoological parks, Wildlife safari parks

WORLD NO TOBACCO DAY

31 MAY 2025

Dangers of Smoking Cigarette

Cigarette smoke contains nicotine, tar, carbon monoxide and more than 4,000 other harmful substances

HEART DISEASE

The risk of the heart attack increases because the heart has to work harder due to narrowing of the blood vessels and increasing heart beat rate

LUNG INFECTION

Damage to lung tissue affects the ability to absorb oxygen

STROKE

Fat deposition on the walls of blood vessels distrups blood flow, resulting in blood clotting which eventually causes a stroke

CANCER

Can cause lung, mouth, throat, oesophagus pancreas, kidney, bladder and cervical cancer

WRINKLES

Causes skin aging and breakdown of elastic fibres in the skin layer

DISTURBANCE TO THE WOMB

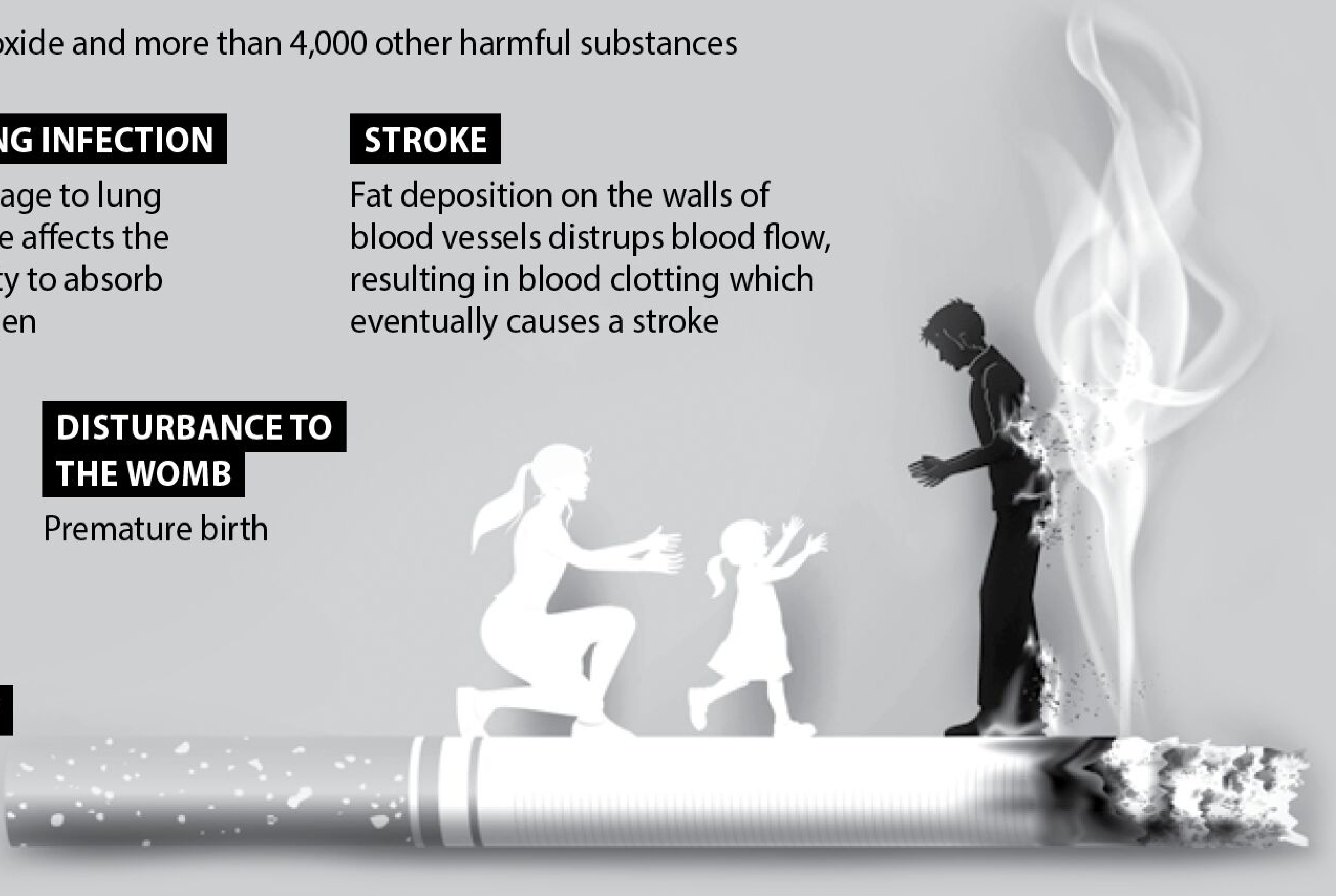
Premature birth

MEN :

Erectile dysfunction

WOMEN : FERTILITY DISORDER AND INFERTILITY

Miscarriage



FIELD NOTE

The Great Indian Bustard

Scientific Name : *Ardeotis nigriceps*

Population : 150

IUCN Red List Status : Critically Endangered

Population Trend : Decreasing

Nest

The Great Indian Bustard was once widespread across 11 states in Western, Central, and Peninsular India, as well as parts of Pakistan. Today, its population is largely confined to Rajasthan and Gujarat. Small populations can be found in Maharashtra, Karnataka, and Andhra Pradesh. They inhabit dry grasslands and scrublands

Features

Great Indian bustards are tall birds with long legs and a long neck; the tallest individuals may stand up to 1.2 metres (4 feet) tall. The sexes are roughly the same size, with the largest individuals weighing 15 kg (33 pounds). Males and females are distinguished by the colour of their feathers. The body is brownish and the wings are marked with black, brown and grey. Males and females generally grow to the same height and weight but males have larger black crowns and a black band across the breast.

Diet

Omnivorous. It prefers insects, consisting mainly of Orthoptera, but also beetles including Mylabris species. It also consumes grass seeds, berries, largely of the genera Ziziphus and Eruca, rodents and reptiles; in Rajasthan, it also hunts Indian spiny-tailed lizards Uromastyx hardwickii.

INTERESTING FACTS

- Almost 90% population declined in 50 years' time.
- Males produce a loud, booming call that can be heard from a considerable distance, used to attract mates and establish territory.
- Adult great Indian bustards have few natural enemies, but they display considerable agitation around certain predatory birds, such as eagles and Egyptian vultures. The only animals that have been observed to attack them are gray wolves.

Breeding

Breeds during the monsoon season, laying a single egg on the ground in undisturbed grasslands. Breeding occurs between March and September, when the inflated fluffy white feathers of the male are inflated and displayed.

Threats

There are two main threats to their existence: habitat loss and hunting. Their natural habitat consists of large expanses of dry grasslands and scrub. However, this habitat is being lost due to agricultural development, overgrazing, and the planting of trees. Great Indian Bustards are hunted for their meat and feathers.

Protection

Efforts to conserve the Great Indian Bustard focus on implementing the National Guidelines for Bustard Recovery Plans, which recommend creating inviolate breeding areas, prioritizing threat mitigation, engaging communities, and establishing conservation breeding programs. These actions are carried out by state forest departments in collaboration with research institutions, local NGOs, and the Rajasthan Pollution Control Board (RSPCB) to identify priority areas and optimize resource allocation. With financial support from the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), holistic *in-situ* and *ex-situ* conservation efforts are being undertaken in Rajasthan and other GIB habitats. These measures also benefit other endangered species, such as the spiny-tailed lizard, chinkara, and blackbuck, by preserving the broader grassland ecosystem.

NCERT XTRACT

This Section Covers Questions Based on Latest **NCERT Textbook** of Class XI

Unit-I : Diversity in the Living World

- The Living World
- Biological Classification
- Plant Kingdom
- Animal Kingdom

1. Which of the following is against the rules of ICBN?
(a) Hand written scientific names should be underlined.
(b) Every species should have a generic name and a specific epithet.
(c) Scientific names are in Latin and written form should be italicized.
(d) Generic and specific names should be written starting with small letters.

2. Major pigments found in Phaeophyceae, *i.e.*, brown algae are
(a) chlorophyll *a*, *b*
(b) chlorophyll *a*, *b*, *c*
(c) chlorophyll *a*, *c* and fucoxanthin
(d) chlorophyll *a*, *d* and phycoerythrin.

3. Archaebacteria and Eubacteria have been included under the Kingdom
(a) Monera
(b) Plantae
(c) Fungi
(d) Protista

4. In a taxonomic hierarchy, the number of common characters will increase as we go from,
(a) Order to Class
(b) Species to Kingdom
(c) Species to Genus
(d) Kingdom to Species.

5. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The digestive system in Platyhelminthes is of incomplete type.
Reason (R) : Platyhelminthes has only a single opening to the outside of the body that serves as both mouth and anus.
In the light of the above statements, choose appropriate answer from the options given below.
(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct and (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is incorrect but (R) is correct.

6. Cell wall is absent in
(a) Mycoplasma
(b) *Nostoc*
(c) *Aspergillus*
(d) *Funaria*.

7. Which one of the following belongs to the Family Muscidae?
(a) Housefly
(b) Fire fly
(c) Grasshopper
(d) Cockroach

8. Members of the Phylum Coelenterata are __________.
(a) asymmetrical animals
(b) terrestrial
(c) sessile or free-swimming
(d) all of these

9. Match Column I with Column II and choose the right option.

	Column I		**Column II**
A.	*Amoeba*	(i)	Has flagella for locomotion
B.	*Paramecium*	(ii)	Moves with the help of cilia
C.	*Trypanosoma*	(iii)	Puts out pseudopodia for locomotion

(a) A-(iii), B-(i), C-(ii)
(b) A-(iii), B-(ii), C-(i)
(c) A-(ii), B-(i), C-(iii)
(d) A-(ii), B-(iii), C-(i)

10. Which of the following is responsible for peat formation?
(a) *Marchantia* (b) *Riccia*
(c) *Funaria* (d) *Sphagnum*

11. Prothallus of pteridophytes is
(a) conspicuous, small, multicellular, free-living, photosynthetic thalloid gametophyte
(b) inconspicuous, small, multicellular, free-living, photosynthetic thalloid gametophyte
(c) inconspicuous, large, unicellular, free-living, photosynthetic thalloid gametophyte
(d) inconspicuous, small, multicellular, free-living, non-photosynthetic thalloid sporophyte.

12. Read the given statements and select the correct option.

Statement I : Cnidarians which exist in both forms, polyp and medusa, exhibit metagenesis.

Statement II : Polyps produce medusae sexually and medusae form the polyps asexually.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

13. Scientific names of plants are based on principles and criteria agreed and given by
(a) IUCN (b) ICZN
(c) ICBN (d) ICPN.

14. Operculum refers to ______________.
(a) gill cover (b) gill perforation
(c) gill slit (d) scales

15. Bacterial viruses usually have
(a) single stranded RNA
(b) double stranded RNA
(c) single stranded DNA
(d) double stranded DNA.

16. Select the correct statement.
(a) *Sequoia* is one of the tallest trees.
(b) The leaves of gymnosperms are not well-adapted to extremes of climate.
(c) Gymnosperms are both homosporous and heterosporous.
(d) *Salvinia*, *Ginkgo* and *Pinus* all are gymnosperms.

17. Match column I with column II for housefly classification and select the correct option using the codes given below.

	Column I		**Column II**
A.	Family	(i)	Diptera
B.	Order	(ii)	Arthropoda
C.	Class	(iii)	Muscidae
D.	Phylum	(iv)	Insecta

(a) A-(iii), B-(i), C-(iv), D-(ii)
(b) A-(iii), B-(ii), C-(iv), D-(i)
(c) A-(iv), B-(iii), C-(ii), D-(i)
(d) A-(iv), B-(ii), C-(i), D-(iii)

18. Strobili or cones are found in
(a) *Salvinia* (b) *Pteris*
(c) *Marchantia* (d) *Equisetum.*

19. The imperfect fungi which are decomposers of litter and help in mineral cycling belong to
(a) Phycomycetes (b) Ascomycetes
(c) Deuteromycetes (d) Basidiomycetes.

20. Which of the following is/are vector?
(a) *Anopheles* (b) *Culex*
(c) *Aedes* (d) All of these

21. Read the following statements about members of Class Aves?
I. Endoskeleton is fully ossified and the long bones pneumatic.
II. The digestive tract of birds has additional chambers, the crop and gizzard.
III. In birds, heart is three chambered.
IV. Birds cannot maintain constant body temperature.
V. Other than tail, oil glands are also present on the skin.

Choose the incorrect statements.
(a) III, IV and V only (b) I, II and III only
(c) I and II only (d) II and III only

22. Which of the following possess scales in birds?
(a) Forelimbs (b) Wings
(c) Hindlimbs (d) Beak

23. Which of the following is not the subphyla of Phylum Chordata?
(a) Urochordata (b) Cephalochordata
(c) Hemichordata (d) Vertebrata

24. Read the given statements and select the correct option.

Statement I: Each different kind of plant, animal or organism can be observed represents a species.

Statement II: The number of species that are known and described range between 170-180 million.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

25. Which of the following does not apply to Ascomycetes?
(a) Mycelium is coenocytic and aseptate.
(b) Commonly known as sac-fungi.
(c) Asexual spores called conidia are produced exogenously.
(d) Sexual spores called ascospores are produced endogenously.
(e) They are saprophytic, decomposers, parasitic or coprophilous.

26. Which of the following statements is wrong about bryophytes?
(a) Bryophytes are also called amphibians of the plant kingdom.
(b) The gametophyte is the main plant body.

(c) Sexual reproduction takes place in the presence of water.
(d) Zygote develops into a gametophyte.

27. Which of the following mammal is oviparous?
(a) *Ornithorhynchus* (b) *Pteropus*
(c) *Macropus* (d) *Equus*

28. Class is the category of taxonomy which includes related
(a) families (b) orders
(c) genus (d) species.

29. Which of the following is correct for amphibians?
(a) External fertilisation and indirect development
(b) Internal fertilisation and oviparous
(c) Viviparous and indirect development
(d) External fertilisation and direct development

30. Pick out the statement that does not apply to viroids.
(a) Infectious agents smaller than viruses.
(b) Cause potato spindle tuber disease.
(c) Have free DNA.
(d) Lack protein coat.

31. Which of the following is a pearl oyster?
(a) *Pinctada* (b) *Loligo*
(c) *Sepia* (d) *Aplysia*

32. Which one of the following is wrongly matched?
(a) *Spirogyra* - Motile gametes
(b) *Sargassum* - Chlorophyll *c*
(c) Basidiomycetes - Puffballs
(d) *Nostoc* - Water blooms

33. Which of the following statements is wrong?
(a) In *Pinus*, male gametophyte is free-living.
(b) The sporophyte of *Polytrichum* is more developed than that in *Marchantia.*
(c) *Wolffia* is the smallest known angiosperm.
(d) *Salvinia* is a heterosporous pteridophyte.

34. Which of the following belongs to Order Sapindales?
(a) Manana (b) Wheat
(c) Mango (d) Onion.

35. Read the following statements related to Class Chondrichthyes.
I. Heart is three chambered.
II. *Torpedo* possess poison sting.
III. *Trygon* possess electric organ.
IV. They are poikilothermous animals.
V. Fertilisation is internal.
Which of the following statements are correct?
(a) I and II only
(b) I, II and III only
(c) IV and V only
(d) II, III and IV only

36. Match the following and choose the correct combination from the options given.

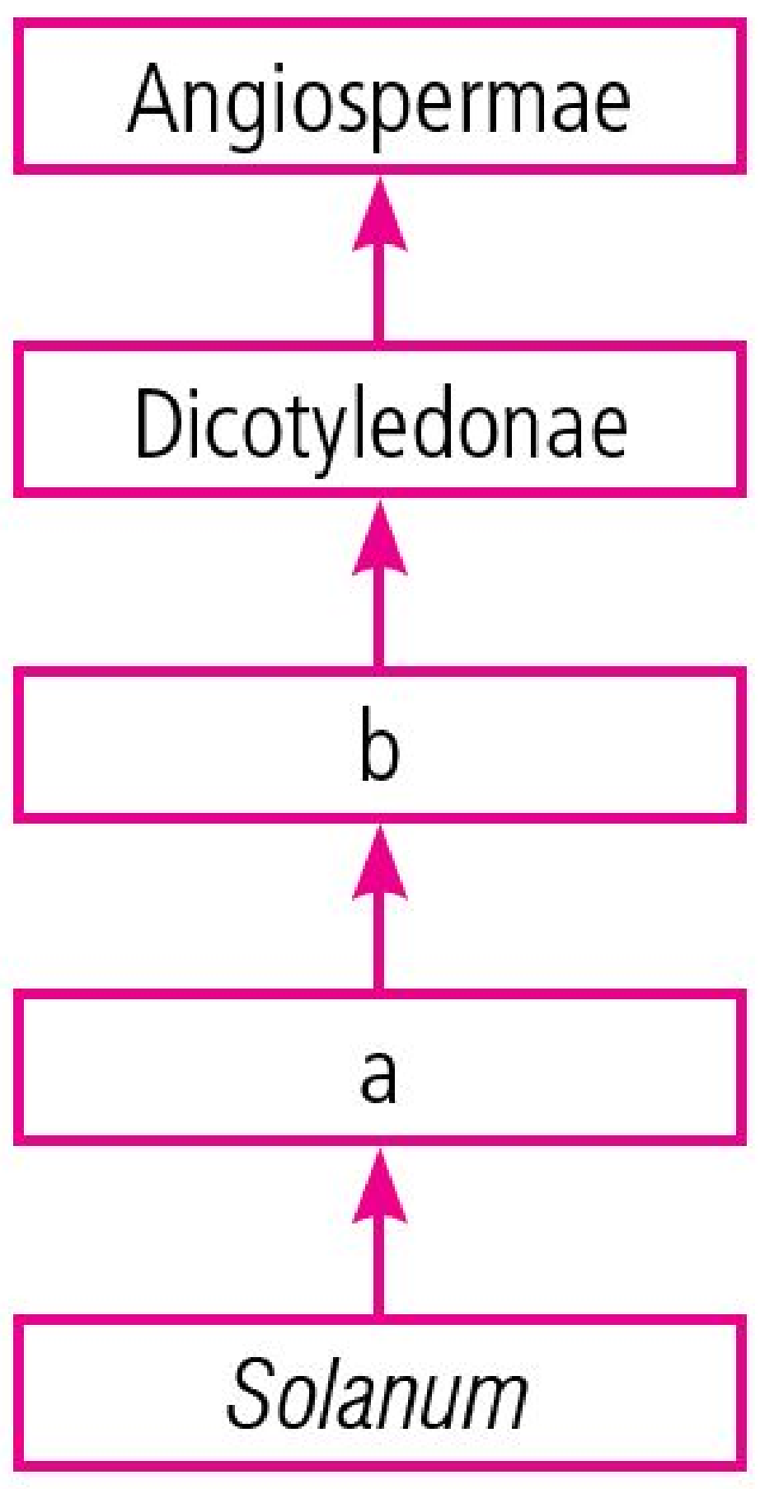
	Column I		**Column II**
A.	Saprophytic protists	(i)	*Trypanosoma*
B.	Golden algae	(ii)	*Plasmodium*
C.	Malarial parasite	(iii)	Desmids
D.	Sleeping sickness is caused by	(iv)	Slime moulds

(a) A-(i), B-(ii), C-(iii), D-(iv)
(b) A-(ii), B-(iii), C-(iv), D-(i)
(c) A-(iv), B-(iii), C-(ii), D-(i)
(d) A-(iii), B-(iv), C-(ii), D-(i)

37. Which one of the following statements is wrong?
(a) Algae increase the level of dissolved oxygen in the immediate environment.
(b) Algin is obtained from red algae, and carrageen from brown algae.
(c) Agar-agar is obtained from *Gelidium* and *Gracilaria*.
(d) *Laminaria* and *Sargassum* are used as food.

38. Pteridophytes include
(a) mosses and liverworts
(b) horsetails and ferns
(c) mosses and horsetails
(d) horsetails and liverworts.

39. Recognise the following flow diagram and find the correct option according to taxonomic hierarchy.



(a) a – Sapindales, b – Anacardiaceae
(b) a – Polymoniales, b – Convolvulaceae
(c) a – Polymoniales, b – Solanaceae
(d) a – Solanaceae, b – Polymoniales

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1.	(d)	**2.**	(c)	**3.**	(d)	**4.**	(a)	**5.**	(b)
6.	(b)	**7.**	(a)	**8.**	(a)	**9.**	(b)	**10.**	(b)
11.	(b)	**12.**	(c)	**13.**	(d)	**14.**	(b)	**15.**	(d)
16.	(d)	**17.**	(d)	**18.**	(d)	**19.**	(d)	**20.**	(c)
21.	(b)	**22.**	(d)	**23.**	(a)	**24.**	(d)	**25.**	(a)
26.	(a)	**27.**	(d)	**28.**	(a)	**29.**	(c)	**30.**	(b)
31.	(d)	**32.**	(c)	**33.**	(c)	**34.**	(b)	**35.**	(d)
36.	(a)	**37.**	(d)	**38.**	(a)	**39.**	(b)	**40.**	(d)

40. Choose the correct statement.

(a) Bryophytes can live in soil but are dependent on water for sexual reproduction.
(b) The sex organs in bryophytes are unicellular.
(c) In bryophyte the main plant body is a gametophyte which is differentiated into true root, stem and leaves.
(d) Common example of liverwort is *Polytrichum*.

41. Arthropods are ______ animals.

(a) bilaterally symmetrical, triploblastic, segmented and coelomate
(b) radially symmetrical, diploblastic, unsegmented and acoelomate
(c) bilaterally symmetrical, diploblastic, segmented and pseudocoelomate
(d) radially symmetrical, triploblastic, unsegmented and acoelomate

42. Read the following statements (A-E) and answer the question which follows them.

(A) In liverworts, mosses, and ferns gametophytes are free-living.
(B) Gymnosperms and some ferns are heterosporous.
(C) Sexual reproduction in *Fucus*, *Volvox* and *Albugo* is oogamous.
(D) The sporophyte in liverworts is more elaborate than that in mosses.
(E) Both, *Pinus* and *Marchantia* are dioecious.

How many of the above statements are correct?

(a) Three (b) Four
(c) One (d) Two

43. The taxonomic category below the level of family is

(a) class (b) kingdom
(c) phylum (d) genus.

44. Which of the following are homosporous pteridophytes?

I. *Selaginella* II. *Lycopodium*
III. *Salvinia* IV. *Equisetum*

(a) I and IV only (b) II and III only
(c) II and IV only (d) III and IV only

45. Gemmae are present in

(a) some liverworts (b) mosses
(c) pteridophytes (d) some gymnosperms.

46. Select the correct sequence of taxonomic categories in case of plants showing hierarchial arrangement in descending order.

(a) Kingdom → Division → Class → Family → Order → Species → Genus
(b) Kingdom → Division → Class → Order → Family → Genus → Species
(c) Kingdom → Phylum → Order → Class → Family → Genus → Species
(d) Kingdom → Division → Family → Order → Class → Species → Genus

47. Which of the following is the largest phylum of Animalia?

(a) Aschelminthes (b) Annelida
(c) Platyhelminthes (d) Arthropoda

48. Of the following statements which are not relevant to Archaebacteria?

A. They live in some of the most harsh habitats.
B. They are present in the gut of several ruminant animals.
C. They are characterised by the presence of a rigid cellulosic cell wall.
D. They include mycoplasma.
E. They are also referred to as blue-green algae.

(a) A, B and C (b) A, C and E
(c) C, D and E (d) A, C and D

49. In plant taxonomy, taxonomic category 'Family' ends with suffix

(a) – aceae (b) – ata
(c) – eae (d) –ales.

50. Archaebacteria differ from eubacteria in

(a) cell membrane structure
(b) mode of nutrition
(c) cell shape
(d) mode of reproduction.

SOLUTIONS

1. **(d) :** According to international code for botanical nomenclature (ICBN) the first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter.

2. **(c) :** Photosynthetic pigments found in Phaeophyceae (brown algae) are — chlorophyll *a*, chlorophyll *c* and carotenoids (carotenes and xanthophylls). The brown colour of these algae is due to the presence of large amount of xanthophyll called fucoxanthin.

3. **(a)**

4. **(d) :** Kingdom is the highest taxonomic category and species is lowest taxonomic category. Species is a natural population of individuals or group of populations which resemble one another.

5. **(a)**

6. **(a) :** Mycoplasma (Kingdom-Monera) are the simplest and smallest free living prokaryotes which are devoid of a cell wall. Plasma membrane forms the outer boundary of the cell of mycoplasma.

7. **(a) :** Housefly (*Musca domestica*) belongs to Family Muscidae.

8. **(c) :** Members of the Phylum Coelenterata are aquatic,mostly marine, radially symmetrical, sessile or free-swimming animals.

9. **(b)**

10. **(d) :** Among the given bryophytes *Sphagnum* is the most important one. It is popularly called bog moss or peat moss.

It is perennial and its growth continues year after year. Older portions undergo death but do not decompose due to secretion of acid that accounts for the antibacterial and antifungal actions. The increasing mass of dead remains accumulate year after year and form a compact dark coloured mass rich in carbon which is called peat. Peat is used as fuels. Paraffin, acetic acid, peat tar and ammonia are formed as by-products of peat obtained for industrial uses.

11. (b) : In pteridophytes, the prothallus is inconspicuous, small, multicellular, free-living, mostly photosynthetic, thalloid gametophyte which is produced by the germination of haploid spores. These gametophytes require cool, damp, shady places to grow, and bear antheridia, archegonia on their ventral surface.

12. (c) : Polyps produce medusae asexually and medusae form the polyps sexually.

13. (c)

14. (a) : Operculum refers to gill cover.

15. (d) : Bacterial viruses (bacteriophages) *e.g.*, T_2, T_4, lambda have double stranded DNA.

16. (a) : *Sequoia sempervirens* is the tallest gymnosperm. The leaves of gymnosperms are well adapted to extremes of climate. This is the reason for gymnosperm to flourish in cold areas where instead of rain, snow is the source of water. Gymnosperms are heterosporous, *i.e.*, produce two different kinds of spores-microspores and megaspores. *Salvinia* is an aquatic pteridophyte.

17. (a)

18. (d) : The sporophytes of pteridophytes bear sporangia that are subtended by leaf-like appendages called sporophylls. In some cases sporophylls may form distinct compact structures called strobili or cones, *e.g.*, *Selaginella*, *Equisetum*.

19. (c) : Deuteromycetes are the imperfect fungi which include all those fungi in which sexual stage is either absent or not known. Some members are saprophytes or parasites while a large number of them are decomposers of litter and help in mineral cycling. *E.g.*, *Colletotrichum*, *Helminthosporium*, etc.

20. (d)

21. (a) : In birds heart is four-chambered. Members of class Aves can maintain their constant body temperature because they are homoiothermous. Skin is dry and without oil glands.

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I		Column II
1. ENGSU	(a)	It is a polymer of fructose.
2. AGIPDRMHA	(b)	These animals have an endoskeleton of calcareous ossicles and these are triploblastic.
3. NEYACPTEH	(c)	A group of related species which has more characters in common in comparision to other species of other genera.
4. LEALGRY	(d)	In leaves, the ground tissue consists of thin-walled chloroplast containing cells.
5. NLNIUI	(e)	Pathogens that attack insects and arthropods, these are also used as biological control agents.
6. ZOERICLOHA	(f)	The process of polymerisation of amino acids to form a polypeptide.
7. LEOMSHYPL	(g)	At this stage, four chromatids of each bivalent chromosomes becomes distinct and clearly appears as tetrads.
8. RNTASAILTON	(h)	In embryo, the embryonal axis has the radicle and root cap enclosed in an undifferentiated sheath.
9. CIDEOHNREATMA	(i)	The exaggerated response of the immune system to certain antigens present in the environment.
10. AULBCOIVUSERS	(j)	A barrier made of rubber that is inserted into female reproductive tract to cover the cervix during coitus.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

22. (c) : In aves, hindlimbs generally have scales and are modified for walking, swimming, perching or clasping the tree branches.

23. (c) : Subphyla of Phylum Chordata includes Urochordata (Tunicata), Cephalochordata and Vertebrata.

24. (c)

25. (a) : Ascomycetes include pigmented moulds, powdery mildews, yeasts, cup fungi, morels and truffles. They have septate hyphae with cell wall containing chitin or fungal cellulose. Nutritionally they are saprophytic, decomposers, parasitic or coprophilous. Asexual reproduction occurs by budding, fission, oidia stage and through exogenously produced conidia. Sexual reproduction takes place by gametic fusion, gametangial contact and autogamy. Ascus (sac) a sporangial sac peculiar to Ascomycetes is formed and hence the group is also called sac fungi.

26. (d) : Antherozoid fuses with the egg to produce the zygote. Zygotes produce a multicellular body called a sporophyte.

27. (a) : *Ornithorhynchus* is an oviparous mammal.

28. (b) : The seven obligate categories used in taxonomy are: Kingdom, Phylum/Division, Class, Order, Family, Genus, Species. Class includes a group of related orders *e.g.*, Class-Mammalia includes different orders such as Rodentia (of rats), Lagomorpha (of rabbits) and Carnivora (of cats and dogs).

29. (a) : In amphibians, sexes are separate. Fertilisation is external. They are oviparous and have indirect development.

30. (c) : Viroids are infectious RNA particles which are devoid of protein coat.

31. (a)

32. (a) : In *Spirogyra*, gametes are non-motile and sexual reproduction takes place by conjugation.

33. (a) **34. (c)**

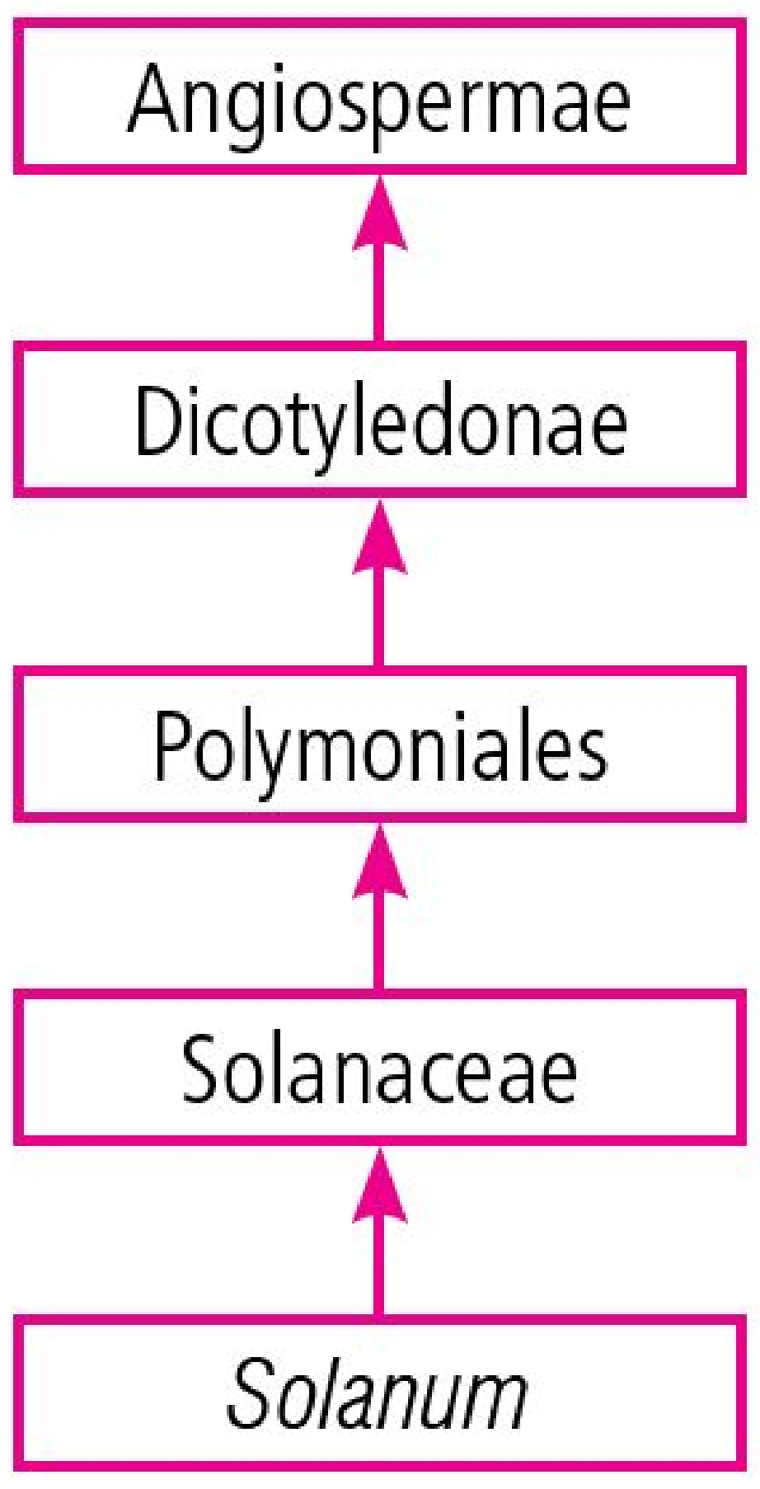
35. (c) : Heart is two chambered (one auricle and one ventricle). *Torpedo* possess electric organs and *Trygon* possess poison sting.

36. (c)

37. (b) : Algin is obtained from brown algae whereas carrageen is obtained from red algae.

38. (b)

39. (d) :



40. (a) : Bryophytes are non-vascular terrestrial plants of moist habitats in which a multicellular diploid sporophyte lives as a parasite on an independent multicellular haploid gametophyte that develops multicellular jacketed sex organs. The gametophyte may be thallose or foliose. It may have root like, stem like and leaf like structures but true roots, stems and leaves are absent. Multicellular jacketed sex organs develop on gametophyte. Bryophytes are classified into liverworts (*e.g.*, *Marchantia*), hornworts (*e.g.*, *Anthoceros*) and mosses (*e.g.*, *Polytrichum*).

They are called amphibians of plant kingdom because they can grow in moist soil but depend on a external film of water for fertilisation. They produce flagellated male gametes which must swim in water to reach egg cell in archegonium.

41. (a) **42. (a)** **43. (d)**

44. (c) : The plants bearing similar spores are called homosporous, *e.g.*, *Pteris*, *Lycopodium*, *Equisetum*, *Adiantum*, etc. *Selaginella* and *Salvinia* are heterosporous, *i.e.*, they bear two types of spores – microspores and megaspores.

45. (a) : In some liverworts like *Marchantia*, special structures called gemmae are present for asexual reproduction.

46. (b) : Taxonomic categories showing hierarchical arrangement in descending order is

Kingdom ⟶ Phylum/Division ⟶ Class ⟶ Order ⟶ Family ⟶ Genus ⟶ Species

47. (d) : Arthropoda is the largest phylum of Kingdom Animalia.

48. (c) : Monerans are grouped into Archaebacteria and Eubacteria. Archaebacteria live in harsh habitats such as extreme salty areas (halophiles), hot springs (thermoacidophiles) and marshy areas (methanogens).Methanogens are present in the gut of several ruminant animals such as cows and buffaloes where they help to digest cellulose and release methane. Cell wall contains proteins and noncellulosic polysaccharides. Mycoplasma are smallest free living prokaryotes and lack a cell wall. Blue green algae or cyanobacteria are eubacteria.

49. (a) : Families end with the suffix 'aceae' in plants, for *e.g.*, Solanaceae, Convolvulaceae, etc.

50. (a) : The archaebacteria are the 'ancient' bacteria that include extremophiles like methanogens, halophiles and thermophiles. They represent some of the most ancient life forms that persist today.

They have both eubacterial and eukaryotic characters besides the features unique to them. Their mode of reproduction, nutrition and cell shape and size resemble typical eubacteria. Their cell walls are made of a variety of polymers, but do not contain peptidoglycan unlike eubacteria. Lipids of their cytoplasmic membranes are linked unlike eubacteria which contain glycerol ester lipids in their cell membrane. ☺☺

Class XI

Monthly test drive

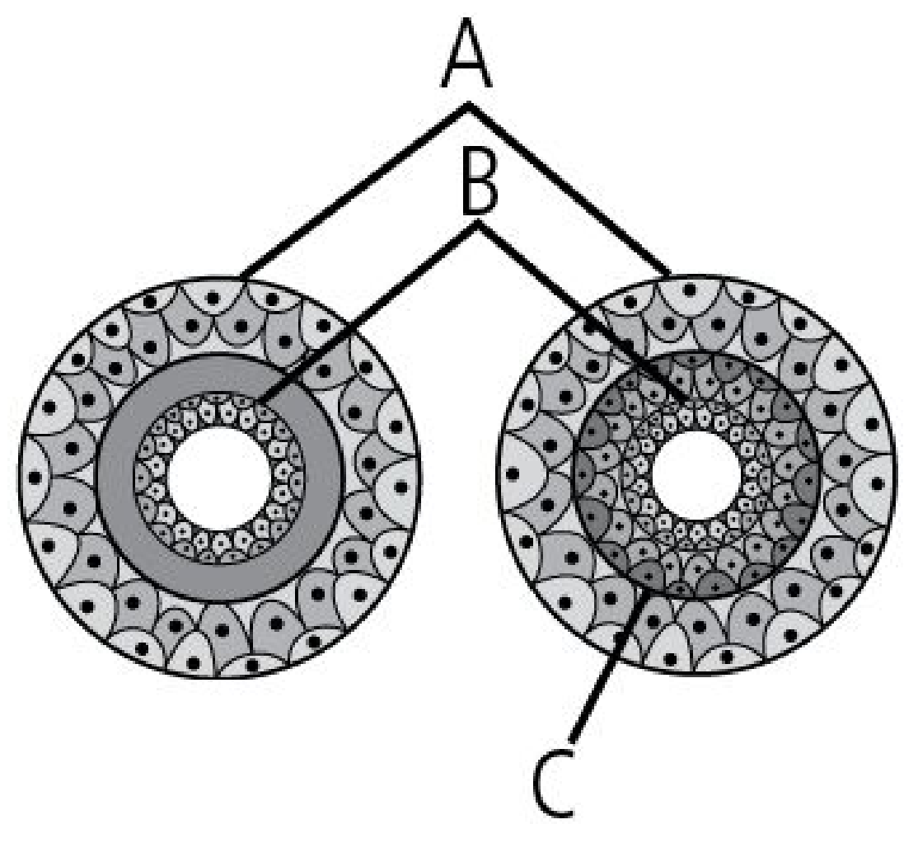
This specially designed column enables students to self analyse their extent of understanding of specific chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Series II Plant Kingdom and Animal Kingdom

Total Marks : 160 **Time :** 40 Min.

1. Laterally attached flagella are seen in
(a) *Gelidium* (b) *Porphyra*
(c) *Ulothrix* (d) *Sargassum*.

2. Which of the following correctly identifies parts A, B and C in the given figure?



(a) A-Endoderm, B-Ectoderm, C-Mesoderm
(b) A-Ectoderm, B-Mesoderm, C-Endoderm
(c) A-Ectoderm, B-Endoderm, C-Mesoderm
(d) A-Endoderm, B-Mesoderm, C-Ectoderm

3. Bryophytes are not characterised by
(a) presence of vascular tissues
(b) presence of chlorophyll
(c) well-developed root system
(d) both (a) and (c).

4. Match column I with column II.

	Column I		Column II
A.	*Physalia*	(i)	Brain coral
B.	*Adamsia*	(ii)	Sea anemone
C.	*Pennatula*	(iii)	Portuguese man-of-war
D.	*Gorgonia*	(iv)	Sea-pen
E.	*Meandrina*	(v)	Sea-fan

Choose the correct answer from the options given below.
(a) A-(iii), B-(ii), C-(iv), D-(v), E-(i)
(b) A-(i), B-(ii), C-(iii), D-(iv), E-(v)
(c) A-(ii), B-(iii), C-(iv), D-(i), E-(v)
(d) A-(iii), B-(iv), C-(i), D-(v), E-(ii)

5. Gymnosperms do not bear fruits because they do not have
(a) seeds (b) ovary
(c) ovule (d) pollen grain.

6. Which of the following is correct about bilateral symmetry?
(a) In this kind of symmetry, when any plane passing through the central axis of the body divides the organism into two identical halves.
(b) In this kind of symmetry, the body can be divided into identical left and right halves by only single plane.
(c) Ctenophores show bilateral symmetry.
(d) Both (a) and (b).

7. Match column I with column II.

	Column I		Column II
A.	Liverwort	1.	Phycoerythrin
B.	Rhodophyceae	2.	Photosynthetic thalloid
C.	Mosses	3.	Gemmae
D.	Prothallus	4.	Protonema

Choose the correct answer from the options given below.
(a) A-3, B-1, C-4, D-2
(b) A-4, B-2, C-4, D-1
(c) A-2, B-1, C-2, D-4
(d) A-1, B-4, C-2, D-3

8. Cnidarians have a central gastro-vascular cavity with a single opening, mouth on __________.
(a) hypostome (b) polyp
(c) medusa (d) cnidoblast

9. Consider the following statements with respect to gymnosperms and angiosperms.
A. In gymnosperms, ovules are developed in flowers.
B. Angiosperms range in size from microscopic *Wolffia* to tall trees of *Sequoia*.
C. In gymnosperms the seeds are not covered.
D. In gymnosperms the male and female gametophytes have an independent free living existence.

Of the above statements

(a) A and B alone are correct
(b) C alone is correct
(c) B and C alone are correct
(d) C and D alone are correct.

10. Given below are two statements.

Statement I : In Phylum Arthropoda, fertilisation is usually external.

Statement II : In Phylum Arthropoda, after fertilisation the development is always indirect.

In the light of the above statements, choose the correct answer from the options given below:

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

11. Leaves of ______ are needle-like to reduce the surface area.

(a) *Cycas* (b) *Pinus*
(c) Moss (d) Fern

12. Identify A, B, C and D in the given table of different algae and their characteristics.

Algae	Stored food	Flagellar number
A	Floridean starch	Absent
Chlorophyceae	**B**	2 – 8
C	Mannitol	**D**

Select the correct option.

	A	B	C	D
(a)	Phaeophyceae	Starch	Rhodophyceae	2
(b)	Phaeophyceae	Laminarin	Rhodophyceae	Absent
(c)	Rhodophyceae	Starch	Phaeophyceae	2
(d)	Rhodophyceae	Starch	Phaeophyceae	Absent

13. Read the following statements about the Phylum Annelida.

I. An open circulatory system is present.
II. Neural system consists of paired ganglia connected by lateral nerves to a double ventral nerve cord.
III. They are metamerically segmented animals.
IV. Reproduction can be asexual or sexual.

Choose the correct statements from the given options.

(a) II, III and IV only
(b) I, II and III only
(c) II and IV only
(d) II and III only

14. Members of the Phylum Aschelminthes are called __________.

(a) flatworm (b) roundworm
(c) tapeworm (d) silkworm

15. Match the following and choose the correct combination.

	Column I		**Column II**
A.	Red algae	1.	*Marchantia*
B.	Liverwort	2.	*Pinus*
C.	Fern	3.	*Polysiphonia*
D.	Gymnosperm	4.	*Adiantum*

(a) A-1, B-2, C-4, D-3 (b) A-2, B-4, C-3, D-1
(c) A-2, B-3, C-1, D-4 (d) A-3, B-1, C-4, D-2

16. Which of the following statements is incorrect related to Echinoderms?

(a) They exhibit organ level of organisation.
(b) Reproduction is sexual.
(c) The adult echinoderms are bilaterally symmetrical but larvae are radially symmetrical.
(d) Both (a) and (c)

17. Which of the following is used as soil binders?

(a) Ferns (b) Moss
(c) Liverworts (d) All of these

18. In aves, _A_ is fully ossified (bony) and the long bones are hollow with _B_.

	A	B
(a)	exoskeleton	air bladder
(b)	exoskeleton	air cavities
(c)	endoskeleton	air bladder
(d)	endoskeleton	air cavities

19. The spreading of living pteridophytes is limited to narrow geographical region because of

(a) requirement of cool, damp and shady place for gametophytic growth.
(b) requirement of water for fertilisation
(c) absence of stomata in leaf and absence of vascular tissue
(d) both (a) and (b).

20. Which of the following are ectoparasites on some fishes?

(a) *Ichthyophis* (b) *Hippocampus*
(c) *Petromyzon* (d) All of these

ANSWERS APRIL 2025

Across	Down
1. *Salvinia*	2. Coleorhiza
3. *Bougainvillea*	4. Cisternae
5. Buttercup	6. Ampulla
7. Biolistic	8. Tracheid

Winner : *Nihal Raj (Rajasthan)*

21. What is the name of the gelatinous coating which covers on the outside of cellulosic wall in vegetative cells of the members of Phaeophyceae?
(a) Stipe
(b) Algin
(c) Fucoxanthin
(d) Laminarin

22. Which of the following is/are incorrect statement(s) related to Chondrichthyes?
(a) Mouth is located ventrally.
(b) Notochord is present only in embryonic stage.
(c) Most of them are oviparous animals.
(d) Both (b) and (c)

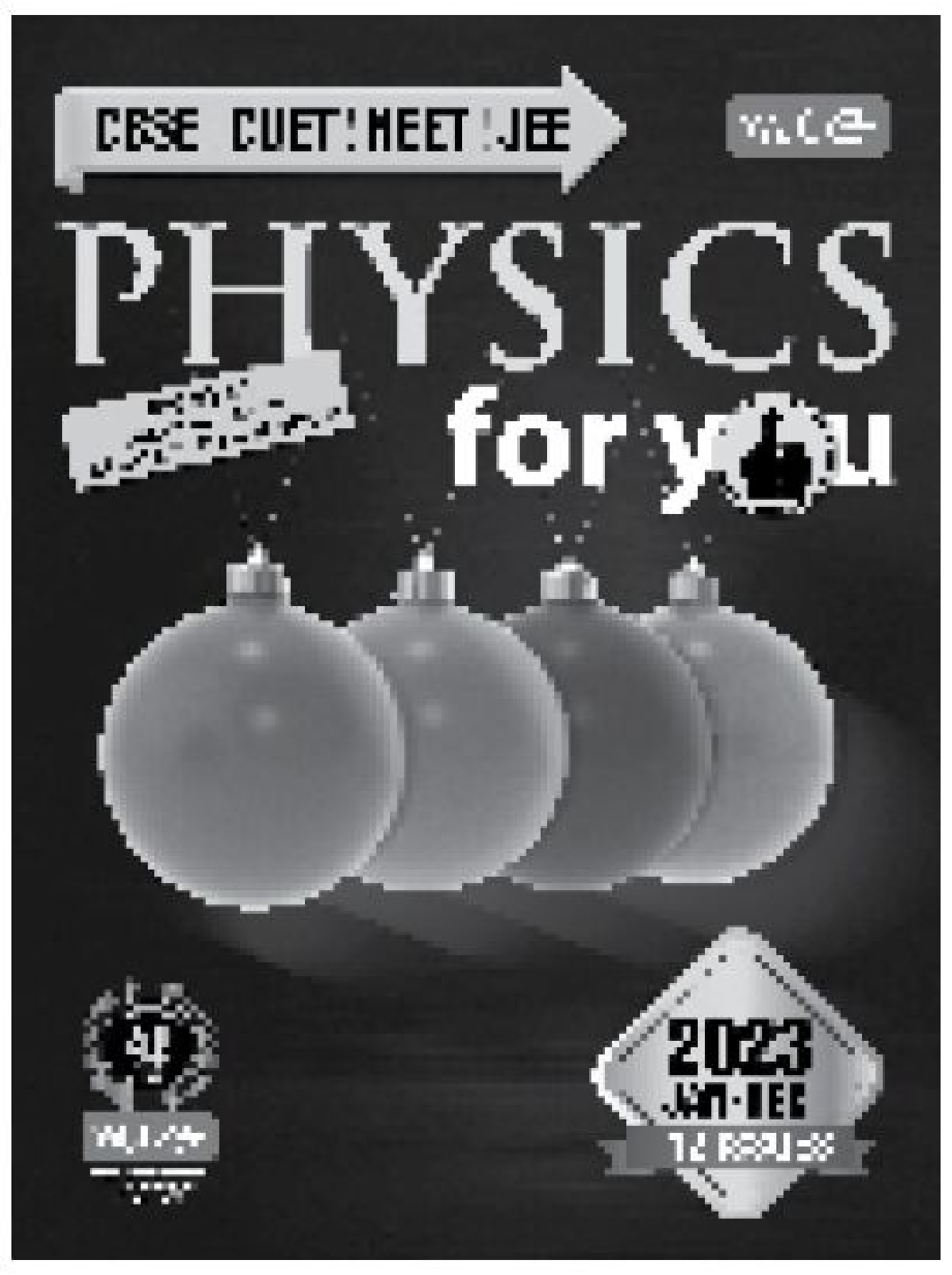
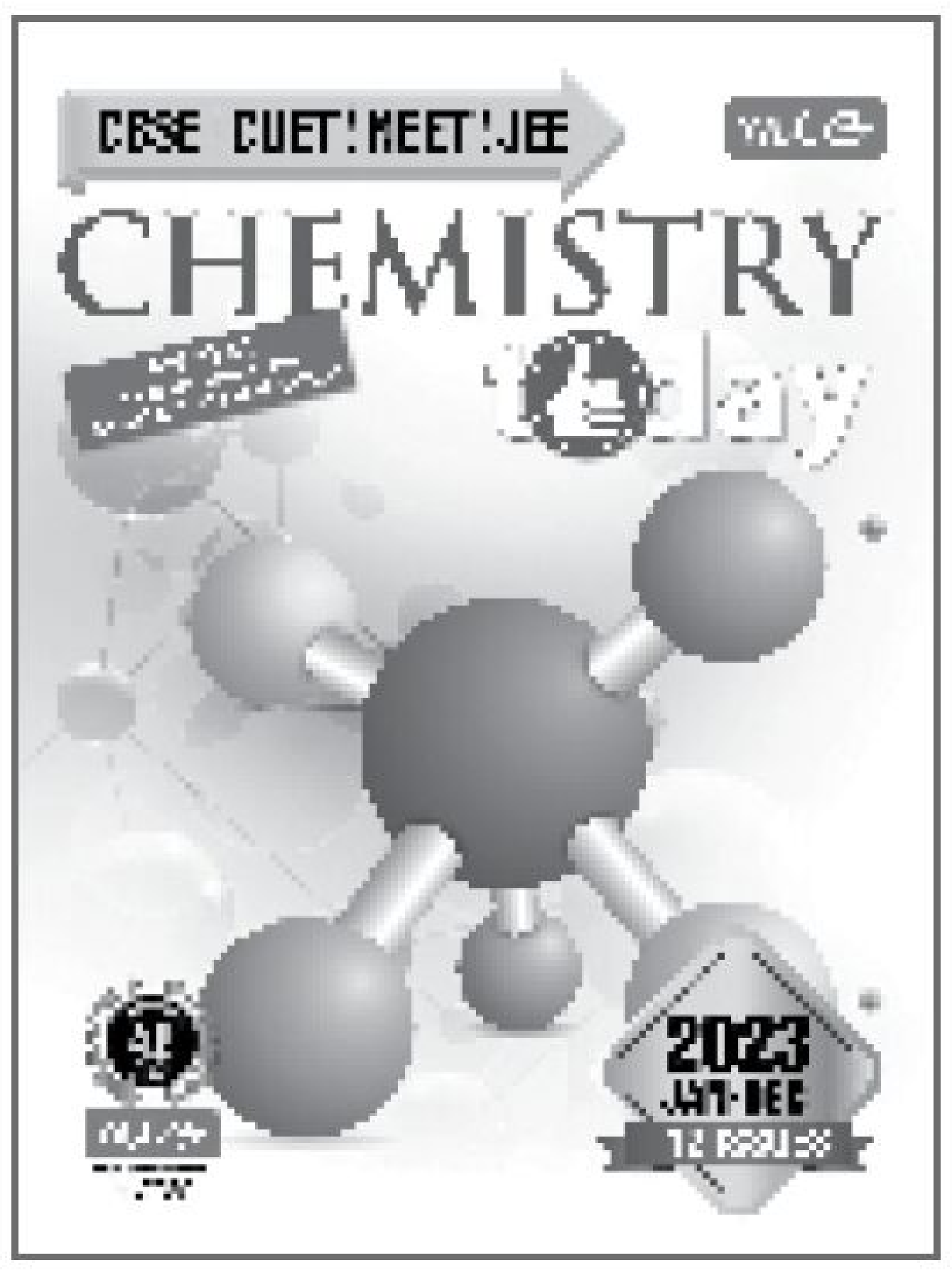
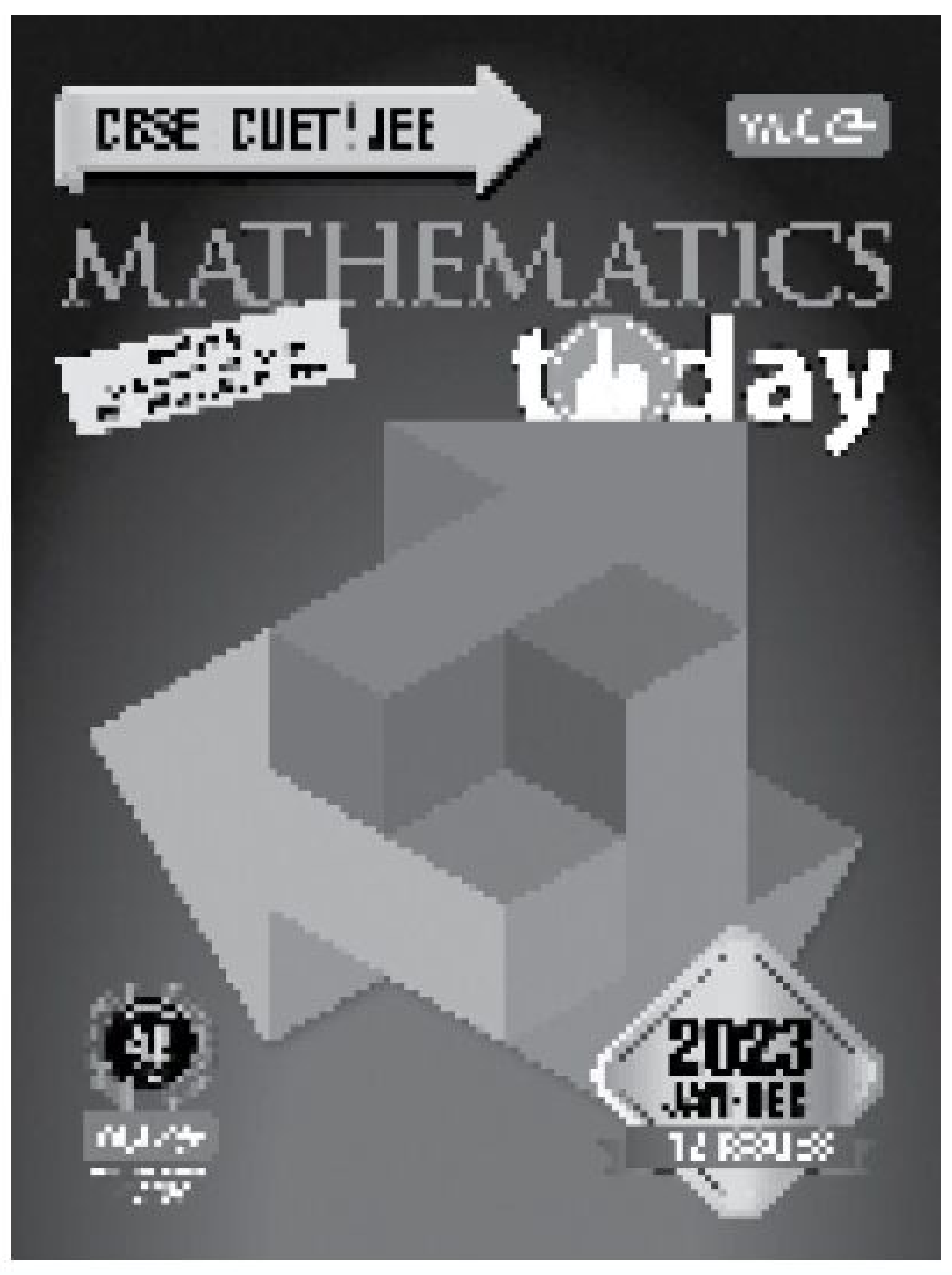
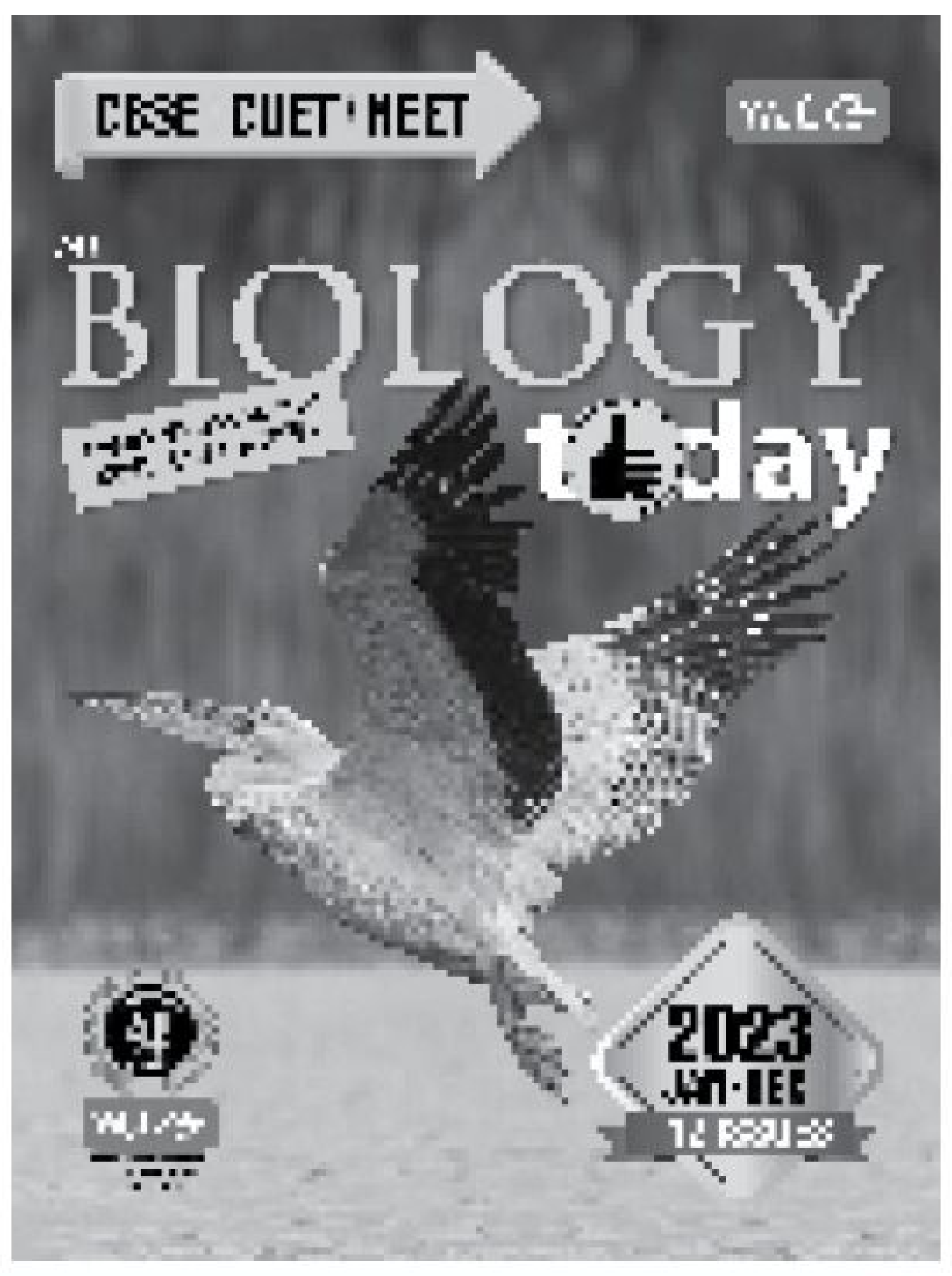
23. Read the given statements and select the correct option.
Statement I : Development of seed habit in pteridophytes is an important step in evolution.
Statement II : In pteridophytes, young embryo develops within the female gametophyte.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

24. Identify the phylum/s which has triploblastic animal.
(a) Arthropoda
(b) Aschelminthes
(c) Platyhelminthes
(d) All of these

25. Sporophyte became more dominant than gametophyte for the first time in which of the following group of plants?
(a) Pteridophytes
(b) Mosses
(c) Liverworts
(d) Gymnosperms

26. Arthropods are ______ animals.
(a) bilaterally symmetrical, triploblastic, segmented and coelomate
(b) radially symmetrical, diploblastic, unsegmented and acoelomate
(c) bilaterally symmetrical, diploblastic, segmented and pseudocoelomate
(d) radially symmetrical, triploblastic, unsegmented and acoelomate

27. Which one of the following is not a characteristic of moss?
(a) The sex organs are produced at the apex of leafy shoots.
(b) The sporophyte in mosses is more elaborate than that in liverworts.
(c) The capsule contains spores which are formed after meiosis.
(d) The leaf stage of mosses develops directly from a spore.

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28. The radula is related to _________.
(a) feeding
(b) digestion
(c) absorption
(d) excretion

29. In bryophytes, the male sex organ antheridium produces ___________ antherozoids.
(a) uniflagellate
(b) non-motile
(c) biflagellate
(d) multiflagellate

30. Read the following statements about Class Cyclostomata.
I. They have elongated body with upto 30 pairs of gill slits.
II. Cyclostomes have a sucking and circular mouth with jaws.
III. The body is devoid of scales and paired fins.
IV. Cranium and vertebral column are cartilaginous.
V. Circulation is of open type.
Choose the correct statements from the given options.
(a) I and II only
(b) III and IV only
(c) I, II and III only
(d) III, IV and V only

31. Which one is a wrong statement?
(a) Haploid endosperm is typical feature of gymnosperms.
(b) Brown algae have chlorophyll *a* and *c* and fucoxanthin.
(c) Archegonia are found in Bryophyta, Pteridophyta and Gymnosperms.
(d) *Gracilaria* is a common member of Phaeophyceae.

32. Which of the following is not the subphyla of Phylum Chordata?
(a) Urochordata
(b) Cephalochordata
(c) Hemichordata
(d) Vertebrata

33. Female reproductive part of bryophytes is
(a) antheridium
(b) oogonium
(c) archegonium
(d) sporangium.

34. Which of the following statements is incorrect about Chordates?
(a) Chordates are bilaterally symmetrical.
(b) In Urochordata, notochord develops only in adult tail.
(c) The members of subphylum Vertebrata possess notochord during the embryonic period.
(d) The notochord is replaced by a cartilaginous or bony vertebral column in adults of the members of subphylum vertebrata.

35. Prothallus of fern contains
(a) sporangia (b) strobilus
(c) sorus (d) gametes.

36. Which of the following is correct for salamander?
(a) External fertilisation and indirect development
(b) Internal fertilisation and oviparous
(c) Oviparous and indirect development
(d) Internal fertilisation and direct development

37. Read the following statements and identify the division.
(i) This is an exceptionally large group of plants occurring in wide range of habitats.
(ii) They provide us with food, fodder, fuel, medicines and several other commercially important products.
(iii) They range in size from tiny, almost microscopic to tall trees over 100 metres.
(iv) The pollen grains and ovules are developed in flowers.
(a) Bryophytes
(b) Pteridophytes
(c) Gymnosperms
(d) Angiosperms

38. Which of the following mammal is oviparous?
(a) *Ornithorhynchus* (b) *Pteropus*
(c) *Macropus* (d) *Equus*

39. Both sporophytic and gametophytic phases are multicellular in
(a) *Selaginella*, *Cycas* (b) *Dryopteris*, *Polytrichum*
(c) *Sphagnum*, *Pinus* (d) *Salvinia*, *Eucalyptus.*

40. Which of the following structures is similar to notochord in Phylum Hemichordata?
(a) Proboscis (b) Collar
(c) Trunk (d) Stomochord

☺☺

Key is published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted ……
No. of questions correct ……
Marks scored in percentage ……

Check your score! If your score is

> 90%	**EXCELLENT WORK !**	**You are well prepared to take the challenge of final exam.**
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74-60%	**SATISFACTORY !**	**You need to score more next time.**
< 60%	**NOT SATISFACTORY!**	**Revise thoroughly and strengthen your concepts.**

Class XII

BIO Digest

This article covers high yield facts of the given topic.

Human Reproduction

- Sexual reproduction is the process by which new organisms are created, by combining genetic information from two individuals of different sexes.
- Sexual dimorphism is evident in human beings, *i.e.*, male and female individuals are separately distinguishable. Reproductive system, whether in male or female is a collection of internal and external organs that work together to produce a new generation of living organisms similar to their parents.
- The external features which provide distinctiveness to the two sexes but have no role in sexual reproduction, are collectively called **secondary sex characters**.
- The specialised cells for reproduction or reproductive units are called gametes. Gametes are of two types : male gametes are **spermatozoa** and female gametes are **ova**. Gametes are formed in separate, paired organs of mesodermal origin, called **gonads**.
- Sperm producing gonads are called **testes** and ova producing gonads are called **ovaries**. Testes and ovaries are known as **primary sex organs**.
- **Puberty** is the process of physical development from the first signs of adolescence to full adult maturity. It is brought about by a series of chemical signals (hormones).
- Onset of puberty varies across individuals and is slightly earlier for girls (about age of 12) than it is for boys (about age of 14).

Acronyms

ABP	Androgen Binding Protein
FSH	Follicle Stimulating Hormone
GnRH	Gonadotropin Releasing Hormone
hPL	Human Placental Lactogen
hCG	Human Chorionic Gonadotropin
hCS	Human Chorionic Somatomammotropin
ICSH	Interstitial Cell Stimulating Hormone
LH	Luteinising Hormone
PRL	Prolactin

MAJOR REPRODUCTIVE EVENTS

- **Gametogenesis** is the formation of gametes. It includes spermatogenesis (formation of sperms) and oogenesis (formation of ova or eggs).
- **Insemination** is the process of transfer of sperms into the genital tract of female.
- **Fertilisation** is the event of fusion of male and female gametes to form zygote within oviduct.

- **Cleavage** is the rapid mitotic divisions of single celled zygote to develop multicellular blastocyst or blastula.
- **Implantation** is the process of attachment of blastocyst stage of embryo, to the uterine wall.
- **Placentation** is the formation of placenta between fetus and uterine wall of the mother to exchange essential materials.
- **Gastrulation** is the event of development of blastocyst into gastrula with three primary germ layers.
- **Organogenesis** is the formation of specific tissues, organs and organ-systems from three primary germ layers.
- **Parturition** is the process of expelling of baby from mother's womb (uterus) *i.e.*, childbirth.

MALE REPRODUCTIVE SYSTEM

- Male reproductive system is located in pelvic region. It comprises of scrotum, a pair of testes, vasa efferentia, epididymis, vasa deferentia, ejaculatory ducts, urethra, penis and certain accessory glands.

Scrotum

- It is a pouch or pigmented sac consisting of loose skin, muscles and connective tissue that hangs from the root, *i.e.*, attached portion of the penis. A **septum** divides the scrotum into two sacs. Each of these sacs contain one testis.
- The scrotum remains connected with the abdomen or pelvic cavity by two **inguinal canals** on each side of the scrotal septum.
- Scrotum acts as a thermoregulator and maintains testes at a temperature 2°C lower than the normal body temperature which is optimal for sperm production.

Testes

- There is a pair of testes that are suspended in the scrotum by the spermatic cords. The testes develop in the abdominal cavity just below the kidneys during early fetal life and then they descend into the scrotum.

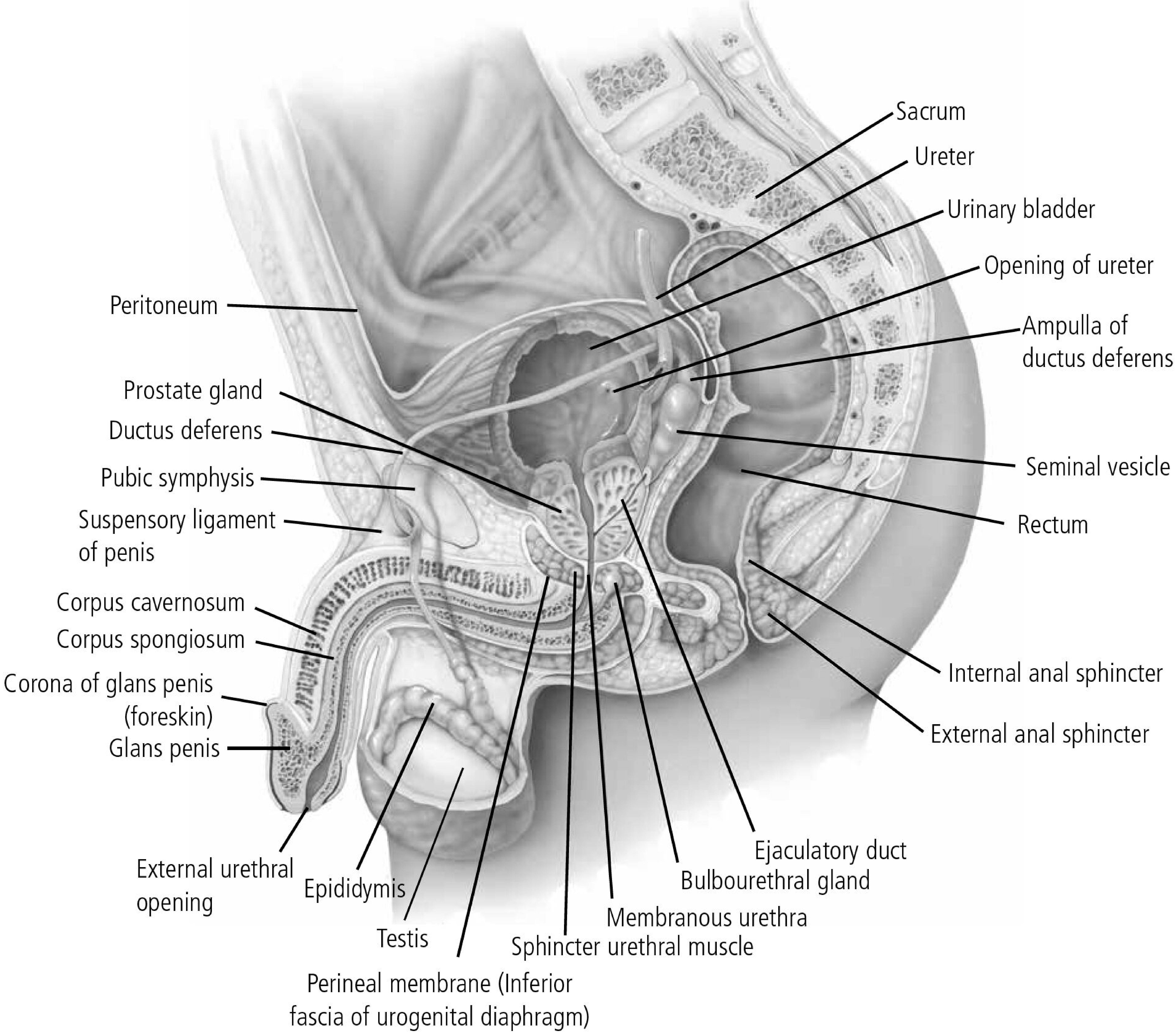

Sacrum
Ureter
Urinary bladder
Opening of ureter
Ampulla of ductus deferens
Peritoneum
Prostate gland
Ductus deferens
Pubic symphysis
Suspensory ligament of penis
Seminal vesicle
Rectum
Corpus cavernosum
Corpus spongiosum
Corona of glans penis (foreskin)
Glans penis
Internal anal sphincter
External anal sphincter
External urethral opening
Epididymis
Testis
Ejaculatory duct
Bulbourethral gland
Membranous urethra
Sphincter urethral muscle
Perineal membrane (Inferior fascia of urogenital diaphragm)

Fig.: Male urogenital system (Mid sagittal view)

- A fibrous cord that extends from the caudal end of the testis to the scrotal wall is called **gubernaculum**.
- Testis is surrounded by three layers : (i) **Tunica vaginalis-** Serous covering of testis, (ii) **Tunica albuginea -** A layer made of fibrous or collagenous connective tissue. (iii) **Tunica vasculosa -** Delicate, loose connective tissues lining testicular lobules, has rich supply of blood capillaries.
- Each testis has around 250 compartments called **testicular lobules** each of which contains several sperm producing coiled tubules called **seminiferous tubules**.
- The lining of seminiferous tubules called germinal epithelium has two types of cells, **spermatogenic cells** and **supporting cells** or **Sertoli cells**.
- In between the seminiferous tubules, in the connective tissue, there are present small groups of rounded endocrine cells, called **interstitial** or **Leydig's cells.**
- Under the influence of luteinising hormone (LH) or interstitial cell stimulating hormone (ICSH), Leydig's cells produce androgens *e.g.*, **testosterone**.
- Testes perform two functions : (a) production of sperms and (b) secretion of male sex hormones.

Male Duct System

- **Rete testis**, **vasa efferentia**, **epididymis** and **vasa deferentia**, **(**or **vas deferens)** are ducts of male reproductive system. These ducts store and transport the sperms from the testis to the outside through urethra.
- The seminiferous tubules join at one end to form a network or **rete testis** from where vasa efferentia arise.
- Vasa efferentia carries spermatozoa from the rete testis to the epididymis.

Epididymis

- It is a mass of long narrow closely coiled tubule which lies along the inner side of each testis.
- At the anterior end of the testis, epididymis is called **caput epididymis**, in which the vasa efferentia opens. The middle part of the epididymis is known as **corpus epididymis**. The posterior end of the epididymis is called as **cauda epididymis**.

Vas Deferens

- It is a continuation of the cauda epididymis. It leaves the scrotal sac and enters the abdominal cavity through the inguinal canal.
- The vas deferens curves over the urinary bladder where it is joined by duct from the seminal vesicle to form the ejaculatory duct. Vasa deferentia carry sperms.

Ejaculatory Ducts

- They are formed by union of ducts from seminal vesicle and vas deferens. They pass through the prostate gland and join the prostatic part of urethra.
- They carry sperms mixed up with secretion of seminal vesicle.

Urethra

- It is the urinary duct which originates from neck of urinary bladder and opens out at the tip of penis. It also receives secretions of prostate and Cowper's glands.
- It carries both urine and semen.
- It consists of three regions - **prostatic urethra** where prostate gland opens, **membranous urethra** at the urinogenital diaphragm and the spongy **penile urethra** that passes through penis.
- The urethra has two sphincters-internal sphincter of smooth muscle fibres at its beginning and external sphincter of striated muscles fibres around its membranous part.

Penis

- The penis is a male copulatory organ.
- The penis contains three cylindrical masses of erectile tissue — two dorsal **corpora cavernosa** and one ventral **corpus spongiosum**. These bodies are surrounded by fibrous tissue.
- The corpus spongiosum, through which the urethra extends, enlarges at its distal end to form a sensitive cone-shaped **glans penis**, covered by loose fold of skin called **prepuce** or **foreskin.**
- During sexual arousal, the three bundles of tissue in the penis become engorged with blood.

Male Accessory Glands

- **Seminal vesicles :** These are paired, glandular, sac-like structures near the base of the bladder, secreting fluids which constitute approximately 60% of the volume of semen. Its secretion contains **fructose** and **prostaglandins**.
- Fructose is the source of energy and prostaglandins stimulate uterine contractions and thus help the sperm to move towards female's oviduct.
- Fructose, which is present in seminal fluid is not produced anywhere else in the body and is used for confirmation of sexual intercourse/rape during forensic test.
- **Prostate gland :** It is a single large gland surrounding urethra. It produces a milky secretion which forms 25% of the volume of semen.
- The secretions of prostate gland also contain glycoprotein **prostate specific antigen (PSA)** which liquefies the clotted semen.
- **Bulbourethral (Cowper's) gland :** These are a pair of glands present on either side of membranous urethra. They secrete an alkaline fluid that neutralises acids from urine in the urethra.

Semen is the collection of secretions from the seminal vesicles, prostate gland, Cowper's glands, sperms from testes. It is ejected from the penis during ejaculation.

SPERMATOGENESIS

- The process of formation of male gametes *i.e.*, sperms is called spermatogenesis. It occurs in the seminiferous tubules of the testes.

Formation of Spermatids

- **Multiplication phase:** The undifferentiated germ cells divide mitotically to form large number of spermatogonia.
- **Growth phase :** Each spermatogonium accumulates large amount of nutrients and chromatin material, grows to a larger primary spermatocyte by the process called spermatocytogenesis.
- **Maturation phase :** Each primary spermatocyte undergoes first meiotic division to form two secondary haploid spermatocytes which in turn produce four spermatids *via* second meiotic division. The first meiotic division is a homotypic division, whereas the second meiotic division is heterotypic.

Formation of Spermatozoa

- The transformation of spermatids into spermatozoa (sperm) is called **spermiogenesis** or **spermateliosis** or **differentiation phase**.

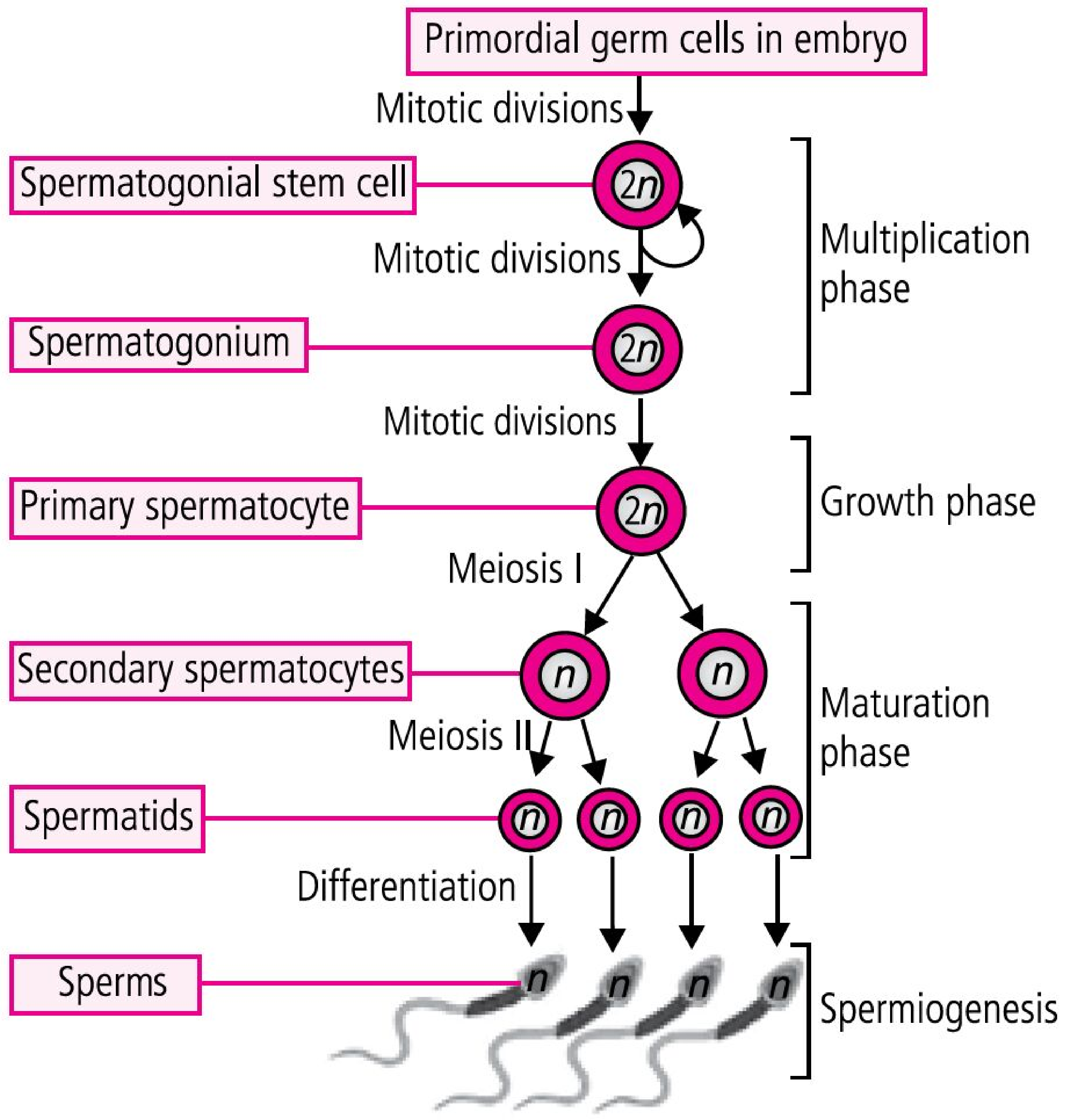


Fig.: Stages in spermatogenesis

- The different changes occurring during spermiogenesis are:
  - (i) Formation of acrosome by Golgi apparatus. The latter then degenerates.
  - (ii) Elongation and condensation of nucleus.
  - (iii) Separation of centrioles into anterior proximal centriole and posterior distal centriole.
  - (iv) Formation of axial filament from distal centriole.
  - (v) Development of mitochondrial spiral around upper parts of axial filament.
  - (vi) Formation of flagellum.
- After their maturation, spermatozoa detach from Sertoli cells, the process is called **spermiation**.

Four sperms are differentiated from a spermatogonium cell. The released sperms are stored in epididymis and first portion of vasa deferentia where they complete their maturation and become capable of fertilising an ovum. Nutrition is provided by epithelium of epididymis.

Sperm or Spermatozoon

- Sperm is a microscopic structure composed of a head, neck, a middle piece and a tail. A plasma membrane envelops the whole body of sperm.
- The sperm head contains an elongated haploid nucleus. The anterior portion of head forms **acrosome** containing proteolytic and lysosomal enzyme.
- The middle piece possesses numerous mitochondria which provide energy for sperm motility.
- The tail helps the sperm to swim in fluid medium.

Disorders of Male Reproductive System

- **Prostatitis** - It is inflammation of prostate generally caused by infection. Prostatitis results in perineal or testicular discomfort, mild dysuria and symptoms of urinary obstruction.
- **Prostate carcinoma** - It is cancer of prostate. Some symptoms are dysuria, difficulty in voiding, increased frequency of urination or urinary retention.
- **Impotence** - It is the inability of the adult male to achieve penile erection. It can be due to physiological, psychological or neuromuscular defects.
- **Sterility** - Sperms are unable to fertilise the ovum due to low count or less motility.
- **Cryptorchidism** - It is a failure of one or both of the testicles to descend into the scrotum. Cryptorchidism is caused by deficient secretion of testosterone by fetal testes. If spontaneous descent does not occur by the age of one year, hormonal injection is given. Retention of testes in the abdomen results in sterility.

INTEXT PRACTICE QUESTIONS

1. **Name the layer of testis which is made up of fibrous or collagenous connective tissues.**
2. **How Sertoli cells are stimulated by Leydig's cells during spermatogenesis?**

FEMALE REPRODUCTIVE SYSTEM

- The female reproductive system consists of a pair of ovaries, a pair of fallopian tubes or oviducts, uterus, vagina, external genitalia or vulva. A pair of mammary glands or breasts are also considered as part of reproductive system due to their role in child care.

Ovaries

- Ovaries are the **primary sex organs** in human female. They are paired structures located in the upper pelvic cavity.
- Each ovary is held in place within peritoneal cavity by several ligaments.

Structure of ovaries

- Anatomically, it is differentiated into following parts — **germinal epithelia**, the outermost layer of the ovary which forms oogonia in the fetus; is made up of squamous or cuboidal epithelium, **tunica albuginea**, sheath of dense connective tissue that lies below germinal epithelium and **ovarian stroma**, differentiated into dense outer **cortex** and less dense inner **medulla**.

> At birth, the ovaries contain an estimated total of 2 to 4 million oogonia (egg mother cells). No more oogonia are formed and added after birth.

Follicular development

- During fetal life, all the oogonia develop into primary oocytes, which then begin a first meiotic division by replicating their DNA. They do not complete the division in the fetus.
- Accordingly, all the eggs present at birth are primary oocytes which contain 46 chromosomes each with two sister chromatids. The cells are said to be in a state of **meiotic arrest**.
- This state continues until puberty and the onset of renewed activity in the ovaries.
- The dormant primary oocyte surrounded by follicular cells in the ovary of a newborn female is called **primordial follicle**.
- At puberty, oogenesis is resumed and primordial follicle enlarges to form **primary follicle**.
- In the primary follicle, development proceeds, the follicular cells keep dividing to form several layers around the primary oocyte and at cells this stage are known as the **granulosa cells.**
- The primary oocyte secretes an acellular glycoprotein layer around itself, called the **zona pellucida.**
- As the granulosa cells keep on dividing, a small cavity appears between these cells called the **antrum** which is filled with a fluid, liquor folliculi, secreted by the granulosa cells. At this stage the follicle is known as **secondary follicle.**
- Around the granulosa cells, connective tissue of ovarian stroma get differentiated into two layers: a **vascular theca interna** and a **fibrous theca externa.**
- The innermost layer of granulosa cells around the zona pellucida consists of columnar cells and is known as the **corona radiata.**

Ovulation

- The fully formed mature dominant follicle with a large antrum is called **Graafian follicle**. It has a **primary oocyte,** which is still in meiotic arrest. Just before ovulation this primary oocyte completes its first meiotic division to form a haploid **secondary oocyte** and a **polar body.**
- This secondary oocyte is released in the peritoneal cavity during ovulation from where it is picked up by the fimbriae of the oviduct.
- The ovulated secondary oocyte is carried into the fallopian tube where fertilisation occurs.

Fallopian Tube

- The function of the fallopian tube is to convey the ovum from the ovary to the uterus by peristalsis.
- Fertilisation of the ovum generally takes place in the upper portion of the fallopian tube *i.e.*, (ampullary-isthmic junction).
- Each fallopian tube (10 - 12 cm) consists of four parts: (i) **Infundibulum :** Funnel shaped free end of the oviduct bearing finger-like processes called fimbriae which help in collection of liberated ovum after ovulation; (ii) **Ampulla:** The widest and longest part of the fallopian tube; (iii) **Isthmus :** Short, narrow, thick-walled portion following ampulla; and (iv) **Uterine part :** Passes through the uterine wall and communicates with the uterine cavity.

Uterus

- It is an inverted pear-shaped highly elastic large part of female reproductive system where development of fetus takes place.
- Uterine wall have three layers : **Perimetrium**, an outer thin covering of peritoneum; **myometrium**, middle thick layer of smooth muscle fibres that shows strong contraction during delivery of the baby and **endometrium**, inner glandular layer lining the uterine cavity.
- Uterus is differentiated into three regions — The upper dome-shaped region called **fundus**, the broad main part called **body** and a small, narrow, cylindrical inferior extremity called **cervix**. Cervix connect to the vagina through external os.

Vagina

- The vagina is a tube, about 10 cm long, that extends from the cervix to the outside of the body. It provides a passage for the menstrual flow, serves as the receptacle for sperm during intercourse and forms part of the birth canal during labour.

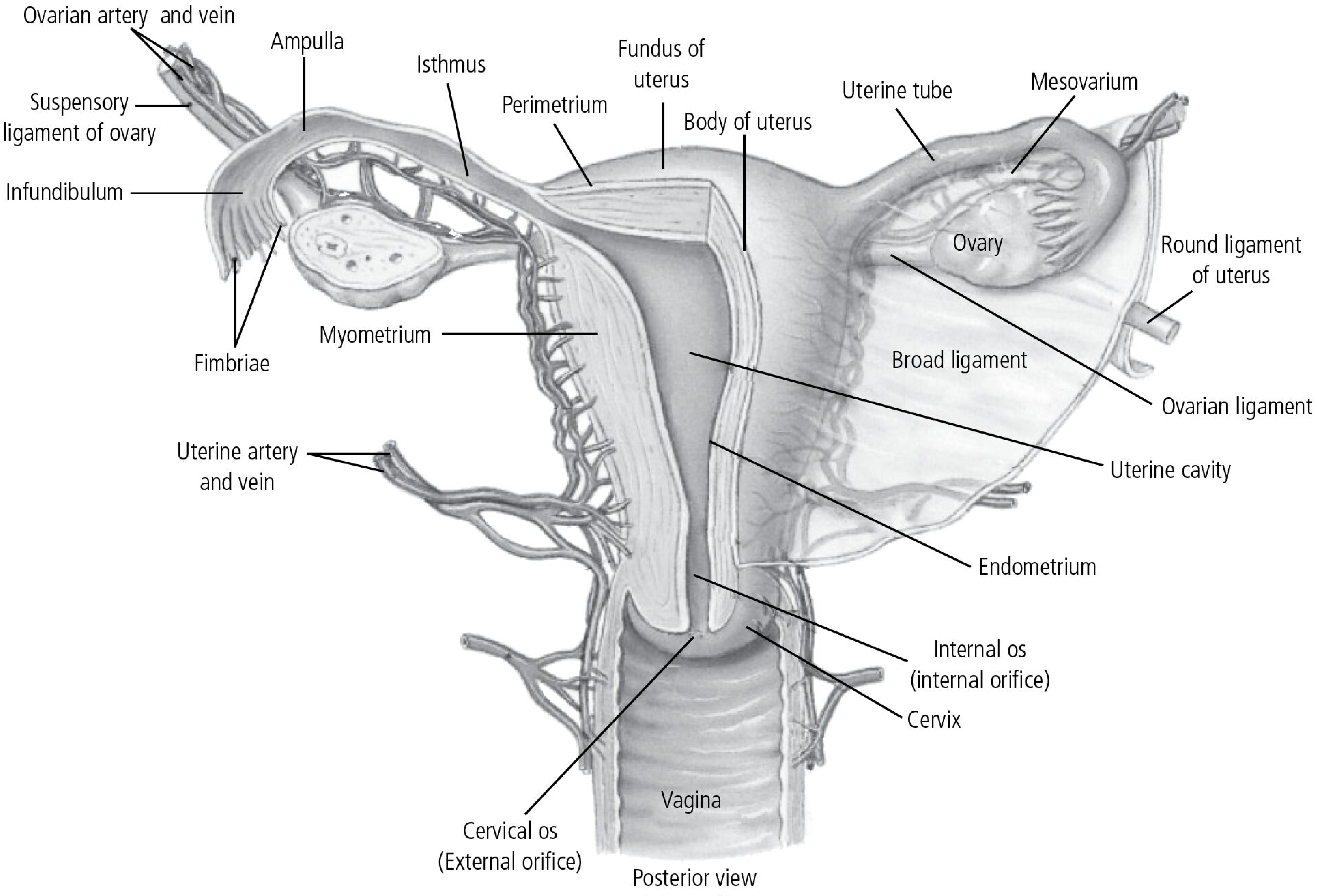

Ovarian artery and vein
Ampulla
Isthmus
Fundus of uterus
Perimetrium
Body of uterus
Uterine tube
Mesovarium
Suspensory ligament of ovary
Infundibulum
Ovary
Round ligament of uterus
Myometrium
Broad ligament
Fimbriae
Ovarian ligament
Uterine artery and vein
Uterine cavity
Endometrium
Internal os (internal orifice)
Cervix
Vagina
Cervical os (External orifice)
Posterior view

Fig.: Female reproductive system

- The opening of the vagina is called the **vaginal orifice**. It is partially covered by a perforate membrane called **hymen**.

External Genitalia (Vulva)

- The female external genitalia include the **mons pubis, labia majora, labia minora, clitoris, vestibule of the vagina,** and **vestibular glands**. External genitalia are collectively called vulva.
- Clitoris contains erectile tissue, it is homologous to glans penis of male.

Female Accessory Glands

- The lesser vestibular glands **(Paraurethral glands or glands of Skene**) are numerous minute glands that are present on either side of the urethral orifice, secreting mucus.
- The greater vestibular glands **(Bartholin's glands)** are a pair of small glands occurring one on each side of vaginal opening, secreting thick, viscous, alkaline fluid. These are homologous to Bulbourethral glands of male.

Mammary Glands

- Mammary glands are modified sweat glands that lie over the pectoralis major muscle.
- Its **glandular tissue** comprises about 15-20 mammary lobes. Each lobe consists of a number of **lobules**, which contain glandular alveoli that produce milk in lactating woman.

Oogenesis

- Gametogenesis in female, *i.e.*, the process of development and maturation of ovum is known as oogenesis.
- It is consists of three phases— multiplication, growth and maturation phase.

Multiplication phase

- During multiplication phase, the germinal epithelium cells divide and detach to produce oogonia, which multiply mitotically and project into the stroma as a cord, **the egg tube of Pfluger**, which later becomes a round mass, the **egg nest**.
- One cell in the egg nest grows to form diploid primary oocyte having the same number of chromosomes as in parent somatic cells, which cease to divide and enter the growth phase.

Growth phase

- This phase of the primary oocyte is very long extending over many years.
- There is accumulation of food materials and other, resources for nourishment of the oocyte.

- Meiosis begins in the primary oocytes soon after their formation. However, the oocytes are arrested in the early part of meiotic prophase I (diplotene stage), the **first resting stage**. They undergo a round of DNA synthesis and chromosome pairing takes place, but meiosis does not proceed further until years later.

Maturation phase

- After primary oocyte has finished its growth, there are two specialised nuclear divisions, first one is the **reductional division**.
- At the beginning of puberty, a small number of primary oocytes are activated each month. However, only one continues meiosis I, producing two haploid cells of dissimilar size, smaller cell is called **first polar body** and larger cell is called **secondary oocyte**.
- The secondary oocyte proceeds with meiosis II but the division gets arrested in metaphase II stage, the **second resting stage**. This is due to an activity called **cytostatic factor** which maintains arrest through preventing loss of **Maturation Promoting Factor (MPF).**
- MPF is a protein in cell cycle which stimulates M-phase of cell cycle.
- It is in this stage of oocyte that the ovum is shed during ovulation. It passes into oviduct, where in the ampulla part, cell cycle will resume only after the entry of sperm.
- Ca^{2+} rise initiated by fertilising sperm results in degradation of regulatory unit of MPF (M-phase Promoting Factor) and activation of **Anaphase Promoting Complex (APC)** thus, promoting completion of cell cycle.
- The first polar body may divide to form two-second polar bodies. Thus from **one oogonium, one ovum** and **three polar bodies** are formed.
- The ovum, is the actual female gamete. The polar bodies take no part in reproduction and soon degenerate due to lack of cytoplasm and food. The formation of non-functional polar bodies enables the egg to get rid of excess chromosomes.

MENSTRUAL CYCLE

- The first menstruation begins at puberty and is called **menarche**. In human females, menstruation is repeated at an average interval of about **28/29 days** and the cycle of events starting from one menstruation till the next, is called **menstrual cycle**.
- The menstrual cycle can be functionally divided into following four phases:

Table : **Phases of menstrual cycle**

Phases	Days	Events
Menstrual phase (Bleeding phase)	1st-5th	Endometrium breaks down, menstruation begins. The cells of endometrium, secretions, blood and the unfertilised ovum constitute the menstrual flow. Progesterone and estrogen production is reduced.
Follicular phase (Proliferative phase)	6th-13th	Endometrium rebuilds, secretion of FSH and estrogen increases.
Ovulatory phase	14th	Both LH and FSH attain a peak level. Concentration of estrogen in the blood is also high and reaches its peak. Ovulation occurs.
Luteal phase (Secretory phase)	15th-28th	Corpus luteum secretes progesterone. Endometrium thickens and uterine glands become secretory.

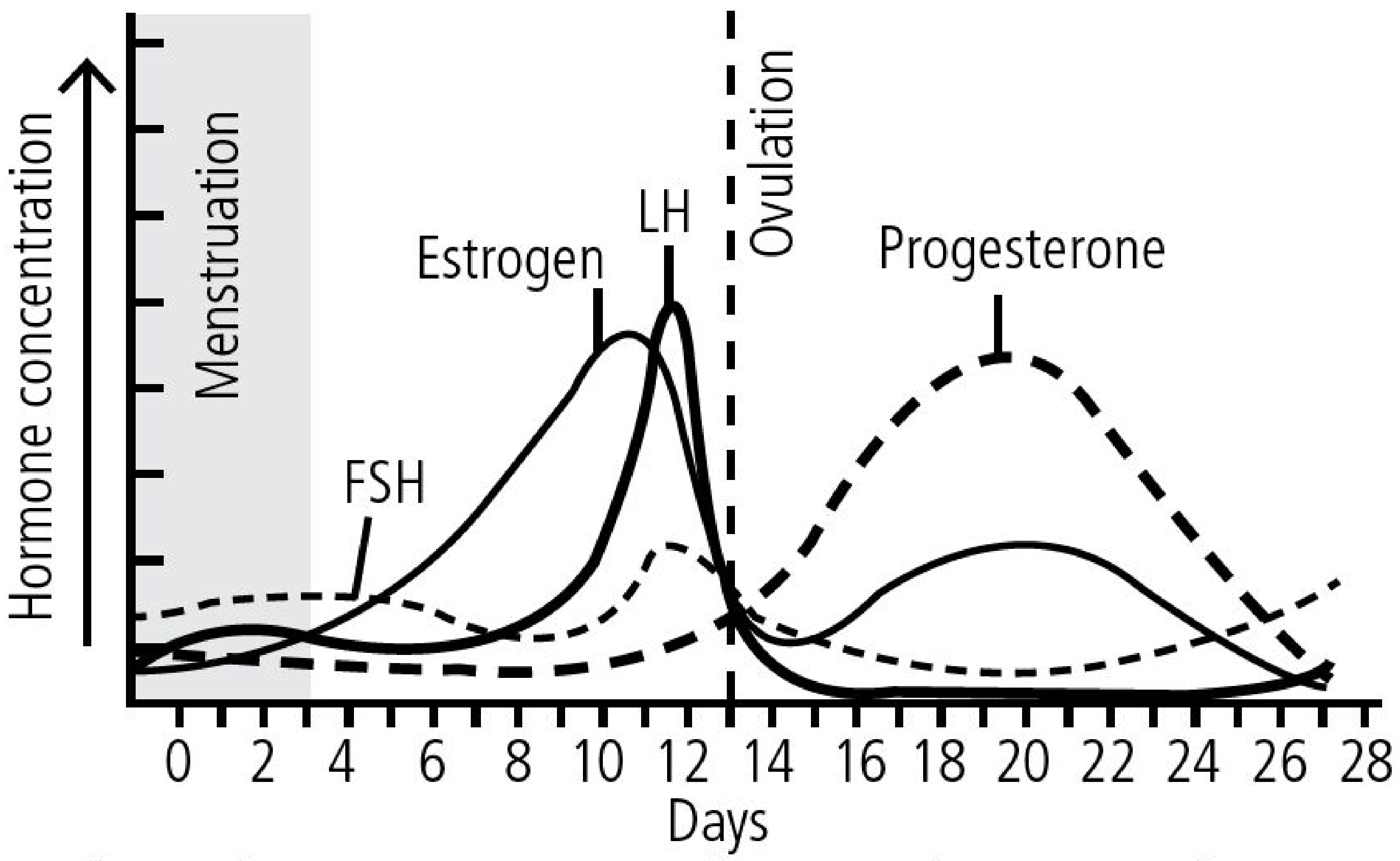


Fig.: Relative concentration of pituitary hormones of anterior lobe (FSH and LH) and ovarian hormones (estrogen and progesterone) during a normal menstrual cycle.

Menopause

- It is the phase in the life of a woman when ovulation and menstruation stop. During this condition, ovaries fail to respond or may be resistant to FSH. In this case, FSH levels are very high and the estrogen level is very low. It occurs between age of 45 to 55 years.

Disorders of Female Reproductive System

- **Breast cancer :** Breast cancer is rarely seen before the age of thirty. Its incidence increases after menopause.
- **Infertility :** Infertility in women is the inability to get pregnant. It may be due to failure to ovulate or some anatomical factor that prevents the union of egg and sperm.

- **Endometriosis :** It is the growth of endometrial tissue outside the uterus. Symptoms include premenstrual pain or unusual menstrual pain.
- **Cervical cancer :** It is relatively slow-growing cancer. Its main risk is that it is unnoticed until it has invaded other tissues.
- **Oophorocystosis (Ovarian cysts) :** Ovarian cysts are fluid filled tumors of the ovary. Such cysts sometimes rupture and regress (get smaller) during pregnancy.
- **Ectopic pregnancy :** It is implantation of embryo at a place other than uterus, generally in the oviduct.
- **Oophoritis :** It is inflammation of ovary, usually caused by an infection.

FERTILISATION AND IMPLANTATION

- Fertilisation is the process of fusion of two types of gametes (spermatozoon and ovum) so as to form a **diploid zygote.**
- In human beings, fertilisation is internal and takes place mostly in the **ampullary-isthmic junction** of the oviduct (fallopian tube).
- The secretions of the female genital tract remove coating substances, deposited on the surface of the sperms particularly those on the acrosome exposing the receptor sites and activating the sperm to penetrate the ovum. This phenomenon of sperm activation is called **capacitation**.
- The **capacitated sperm** undergoes acrosomal reaction and releases various chemicals contained in the acrosome. These chemicals are collectively called **sperm lysins.**
- Due to **acrosomal reaction** plasma membrane of the sperm fuses with the plasma membrane of the secondary oocyte so that the sperm contents enter the oocyte.
- **Cortical reaction,** after the fusion of the plasma membrane of oocyte with sperm, the cortical granules fuse with the plasma membrane releasing their contents along with cortical enzymes which hardens the zona pellucida preventing entry of additional sperms, *i.e.*, polyspermy.
- Entry of the sperm induces the completion of the meiotic division of the secondary oocyte. The second meiotic division is also unequal and results in the formation of **second polar body** and a haploid ovum (ootid). Haploid nucleus of the sperm and that of the ovum fuse together to form a diploid **zygote.**

EMBRYONIC DEVELOPMENT

- **Embryonic development** or **embryogenesis** is the development of embryo from fertilised ovum and its subsequent development into a young organism.

Table: **Principal events during embryonic development**

	Stage	Time period	Principal events
(i)	Zygote	12-14 hours after ovulation	Haploid sperm unites with haploid egg, making the latter a diploid zygote with unique genotype.
(ii)	Cleavage	30 hours to 3 days	Mitotic divisions increase number of cells without increasing total cytoplasmic mass.
(iii)	Morula	Third to fourth day	Solid ball formed, comprising outer layer of small cells around an inner mass of large cells.
(iv)	Blastocyst	Fifth day to end of second week	Hollow ball formed, comprising trophoblast, embryonic knob and blastocyst cavity, implantation occurs, embryonic disc forms, primary germ layers established.

- Blastocyst then gets attached to the endometrium (trophoblast) and the inner cell mass gets differentiated as the embryo.
- After attachment, the uterine cells divide rapidly and covers the blastocyst. As a result, blastocyst become embedded in the endometrium. This is called **implantation**. It begins about seventh day after fertilisation of ovum.
- Implantation leads to **pregnancy**. In human beings it is approximately 9 months ±7days. If hCG (Human Chorionic Gonadotropin) is present in a woman's urine it indicates her pregnancy. After implantation, finger-like projections appear on the trophoblast called **chorionic villi**. Chorionic villi and uterine tissue becomes interconnected with each other and jointly form **placenta** between mother and developing fetus.
- Placenta connects with fetus by a rope-like structure called **umbilical cord**.
- Transformation of blastocyst into gastrula by formation of primary germ layers by rearrangement of cells is called **gastrulation**.
- In all triploblastic animals, three germ layers — ectoderm, mesoderm and endoderm are formed.

WHO AM I ...

"I am a process in which spermatids are transformed into sperm."

...search me ☺

Table : **Structures derived from the three embryonic germ layers during organogenesis**

Ectoderm	Mesoderm	Endoderm
• Epidermis of skin and its derivatives (including sweat glands, hair follicles). • Epithelial lining of mouth and rectum. • Sensory receptors in epidermis. • Cornea and lens of eye, nervous system. • Adrenal medulla, epithelium of pineal and pituitary glands.	• Notochord, skeletal and muscular systems. • Muscular layer of stomach, intestine, etc. • Sclera, choroid, ciliary body. • Excretory, circulatory and lymphatic systems. • Dermis of skin and lining of body cavity • Adrenal cortex.	• Epithelial lining of digestive tract. • Epithelial lining of respiratory system. • Lining of urethra, urinary bladder and reproductive system. • Epithelium of liver, pancreas, thymus, thyroid and parathyroid glands.

- The growing embryo/fetus develops four membranes called the **extra-embryonic** or **fetal membranes.** These include
  - (i) **Chorion** completely surrounds the embryo and protects it, takes part in the formation of placenta.
  - (ii) **Amnion** is the membrane that closely covers the embryo when first formed. The space between amnion and embryo is filled with amniotic fluid. Amniotic fluid absorbs shock, regulates temperature of fetus and prevents desiccation of the embryo.
  - (iii) **Allantois** is small and non-functional except for furnishing blood vessels to the placenta.
  - (iv) **Yolk sac** is non-functional in human beings except that it functions as the site of early blood cell formation.

PARTURITION

- Parturition is the act of expelling the full-term young one from the mother's uterus at the end of gestation.
- **Gestation** (pregnancy) is completed in about **9 months** from conception.
- Process of parturition is induced by both nervous system and hormones secreted by the endocrine glands of the mother.
- The signals for childbirth (parturition) originate from the fully matured **fetus** and **placenta** which induce mild uterine contractions called **fetal ejection reflex.**
- This causes quick release of oxytocin which promotes contraction of uterine muscles from the maternal posterior lobe of pituitary gland. The amount of oxytocin is increased just before and during **"labour pains"** (pains of childbirth).
- **Relaxin** secreted by the placenta increases the flexibility of the pubic symphysis and ligaments of the sacroiliac and sacrococcygeal joints and helps to dilate the uterine cervix during labour pains.
- The hormone most recently found to be produced by the placenta is **corticotropin-releasing hormone (CRH),** which in non-pregnant women is secreted only by neurosecretory cells in the hypothalamus.

LACTATION

- The mammary glands of the female undergo differentiation during pregnancy and start producing milk towards the end of pregnancy by the process called **lactation**.
- Secretion of milk is influenced by **prolactin**, secreted by anterior lobe of the pituitary gland and ejection of milk is stimulated by **oxytocin**, secreted by posterior lobe of the pituitary gland. This helps the mother in feeding the newborn.
- The first milk which comes from the mammary glands of mother produced during initial 2 or 3 days after childbirth is called **colostrum**. Colostrum contains antibodies **(IgA)** that provide natural passive immunity to the newborn.

INTEXT PRACTICE QUESTIONS

3. Which embryonic germ layer produces dermis of skin?

4. In which phase of menstrual cycle, endometrium rebuilds and secretion of FSH and estrogen increases?

Reproductive Health

- Reproductive health refers to the healthy reproductive organs with their normal functions.
- According to the World Health Organisation (WHO), the reproductive health means a total well being in physical, emotional, behavioural and social aspects in reproduction.
- Reproductive health problems include population explosion, low birth weight, preterm birth, reduced fertility, impotency, menstrual disorder and sexually transmitted diseases.

STRATEGIES FOR REPRODUCTIVE HEALTH PROBLEMS

- Government of India undertook a number of programmes to attain total well being of reproductive health as a social goal.
- '**Family Planning programmes**' were initiated in 1951 and were periodically assessed over the past decades.
- Improved programmes covering wider reproduction-related areas are currently in operation under the popular name '**Reproductive and Child Health Care (RCH) Programmes**'.
- **Sex education** should be introduced in schools to provide right information about myths and misconceptions about sex-related aspects.
- Statutory ban on **amniocentesis** for sex-determination to legally check increasing female feticides, massive immunisation of children etc., are some appreciable steps.
- Research on various reproduction-related areas are encouraged and supported by governmental and non-governmental agencies to find out new methods and/or to improve upon the existing ones.
- Better awareness about sex related matters, increased number of medically assisted deliveries and better post-natal care leading to decreased maternal and infant mortality rates, increased number of couples with small families, better detection and cure of STDs and overall increased medical facilities for all sex-related problems, etc. all indicate improved reproductive health of the society.

POPULATION EXPLOSION

- Human population is increasing at a very fast rate over a relatively short period of time. Such a rapid or exponential increase in population is termed as **population explosion**.
- Increased health facilities along with better living conditions has an explosive impact on the growth of population.

Reasons for population explosion

- Early marriage
- Religious orthodoxy against family planning
- Increased health facilities
- Better food storage and transportation facilities
- Increased sanitation and life amenities
- Better means of protection from natural calamities
- Reduced death rate particularly IMR and MMR
- Desire of male child
- Increased agricultural production
- Lack of social awareness
- Advanced post-natal care

- In 2016, the population of India was reported as 1.32 billion (May 15, 2016), second to China with 1.37 billion people. According to most recent UN data, population of India is 1.35 billion (2018).
- Over population leads to a number of problems which exert adverse impact on a nation.
- It increases poverty, unemployment, scarcity of food, water, natural resources, home, etc. It also causes eco-degradation, energy crisis, etc. So, over population must be checked to maintain continuity of human race.

BIRTH CONTROL METHODS

- The regulation of conception by various preventive methods or devices to limit the number of offspring is called **birth control** or **contraception**.

Temporary Methods

- Temporary methods include natural methods, barrier methods, chemical methods, IUDs, oral contraceptive pills, subcutaneous implants and hormone injections.
- **Natural methods** avoid meeting of sperm and ovum by following ways:

(i) **Periodic abstinence or rhythm method :** The couples avoid or abstain from coitus from day 10th to 17th of the menstrual cycle because ovulation can occur during this period. The effectiveness of this method is limited.

(ii) **Coitus interruptus** or **withdrawal method :** It involves withdrawal of penis from vagina by the male just before ejaculation. Effectiveness is moderate.

(iii) **Lactational amenorrhea method :** This method is based on the fact that ovulation and therefore the menstrual cycle does not occur during the period of intense lactation following parturition. It can be effective only upto a maximum period of six months after child birth.

- **Barrier methods** prevent the meeting of sperm and ovum by use of following barriers:

(i) **Condoms** are made of thin rubber/latex sheath used to cover penis in male or vagina and cervix in female just before coitus. Condom is also a safeguard against AIDS and other sexually transmitted diseases (STDs). Female condoms are called **femidoms**.

(ii) **Diaphragms**, **Cervical caps** and **Vaults** are also made of rubber and are inserted into the female reproductive tract to cover the cervix before coitus.

- **Chemical methods** include foam tablets, creams, jellies and pastes that are inserted in the vagina before intercourse to prevent sperms from entering the uterus. These contain spermicides such as lactic acid, citric acid, boric acid, zinc sulphate and potassium permanganate which kill sperms.
- **Intrauterine devices (IUDs)** are plastic or metal objects which are inserted by doctors in the uterus through vagina. These are available as **non-medicated IUDs** (*e.g.*, Lippes' loop), **copper releasing IUDs** (CuT, Cu7, Multiload 375) and **hormone releasing IUDs** (Progestasert, LNG-20). IUDs increase phagocytosis of sperms within the uterus and the Cu^{2+} ions released by these IUDs suppress the sperm motility and fertilising capacity of sperms. The hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms.
- **Oral contraceptives** are physiological contraceptives used in the form of pills. These are of two types:

(i) **Combined pills** are most commonly used oral contraceptive pills which contain synthetic progesterone and estrogen to check ovulation.

(ii) **Mini pills** contain progestin (progesterone like synthetic hormone) only.

> **Saheli,** a new oral contraceptive pill for female contains a **non-steroidal** preparation called **centchroman** which is taken once in a week after an initial intake of twice a week dose for three months.

- **Morning after pills** are also known as **emergency contraceptives**. These pills can prevent pregnancy when taken within 72 hours after unprotected intercourse. It is not a regular contraceptive method.
- Hormonal pills act in four ways: (i) Inhibition of ovulation. (ii) Inhibition of motility and secretory action of oviducts. (iii) Impairing cervix's ability to allow sperm passage and transport. (iv) Alteration in uterine endometrium making it unsuitable for implantation.
- **Subcutaneous implants** or **norplant** is a six matchstick-sized capsule containing steroid which is inserted under the skin of the inner arm, above the elbow. The capsules slowly release the synthetic progesterone for about five years. It is very safe, convenient, effective and long-lasting.
- **Hormone injections** are progesterone derivative injections which are given once every three months.

Permanent Methods

- These include sterilisation by surgery. Surgical methods block gamete transport and prevent fertilisation. It is effective but **reversibility is very poor**. It includes:
  (i) **Vasectomy** is the sterilisation procedure in males. In this method, a small part of vas deferens is removed or tied up through a small cut on the scrotum.
  (ii) **Tubectomy** is the sterilisation procedure in females. In this method, a small part of the fallopian tube is removed or tied up through a small cut in the abdomen or through vagina.

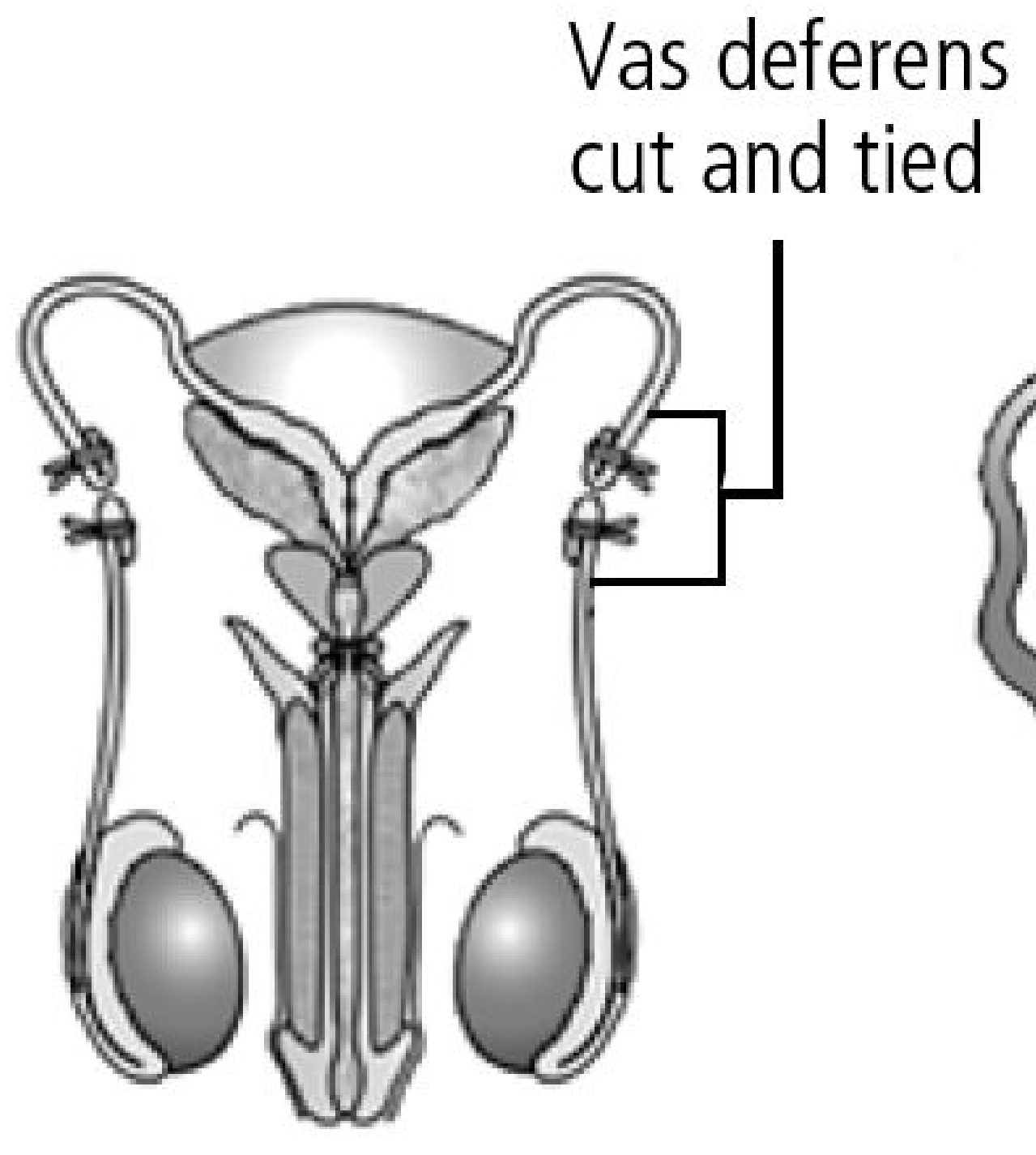


Fig.: Vasectomy

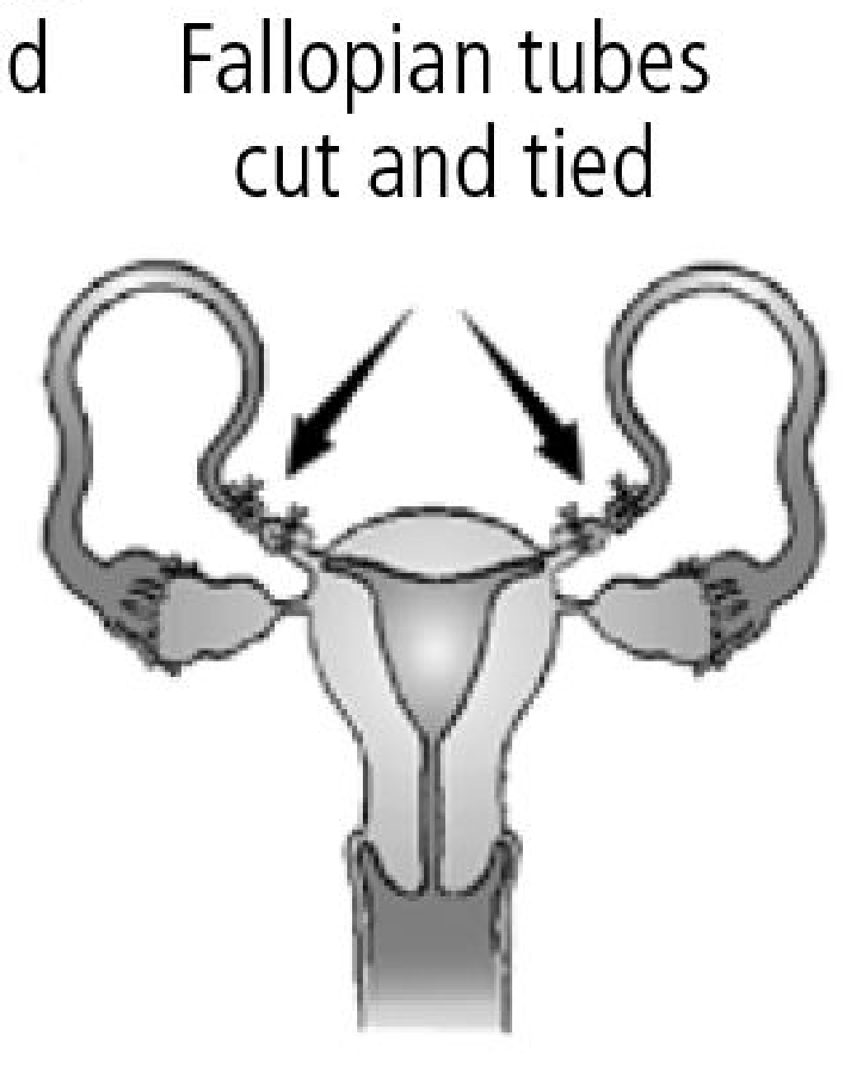


Fig.: Tubectomy

MEDICAL TERMINATION OF PREGNANCY (MTP)

- **Medical termination of pregnancy (MTP)** or **induced abortion** is **intentional** or **voluntary termination** of pregnancy before the fetus becomes viable. Nearly 45 to 50 million MTPs are performed in a year all over the world which accounts to 1/5th of the total number of conceived pregnancies in a year.
- MTP is comparatively safe **upto 12 weeks** (the first trimester) of pregnancy.
- **Government of India legalised MTP in 1971**.
- At present, termination is legally allowed upto 28th weeks of pregnancy, if the gynaecologist consider the need for abortion.

SEXUALLY TRANSMITTED DISEASES

- Infections and diseases which are transmitted through sexual contact with infected persons are collectively called **sexually transmitted diseases (STDs)** or **venereal diseases (VD)** or **reproductive tract infections (RTI)**.
- Except HIV infection, Hepatitis-B and genital herpes, all other STDs are completely curable if detected early and treated properly. (*Some common STDs are tabulated as follows*):

Table : Some common STDs

Disease	Pathogen	Transmission	Incubation period	Symptoms	Diagnosis	Treatment
I. STDs caused by Bacteria						
Syphilis	*Treponema pallidum*	Through sexual contact and from mother to child.	10-90 days	Symptoms of the **first stage** are painless ulcer on the genitals and swelling of local lymph glands. In the **second stage,** chancre is healed and there are skin lesions, rashes, hair loss, swollen joints and flu-like illness occasionally. In the **tertiary stage,** chronic ulcers appear on palate, nose and lower leg. There can be paralysis, brain damage, blindness, heart trouble and aortic impairment.	(a) Antibody detection, *e.g.*, VDRL (b) ELISA test	Antibiotics, *e.g.*, penicillin, tetracycline
Gonorrhea	*Neisseria gonorrheae*	Sexual contact, common toilets and under clothes	2-5 days	The bacterium lives in genital tubes, produces pus containing discharge, pain around genitalia and burning sensation during urination. **It may lead to arthritis and eye infection in children of gonorrhoea affected mothers.**	Gram staining of discharge and culture	Antibiotics *e.g.*, penicillin, ampicillin
II. STDs caused by Viruses						
AIDS	Human Immuno-deficiency virus (HIV)	Through semen and blood.	6 months - 10 years	Fever, lethargy, pharyngitis, weight loss, nausea, head-ache, rashes, etc. **HIV** attacks **helper T-lymphocytes,** the patient gets immune deficient.	ELISA, PCR	Anti-retroviral drugs such as zidovudine and didanosine
Hepatitis B	Hepatitis B virus (HBV)	Blood transfusion, sexual contact, saliva, tears, intravenous drug abuse, tatooing, ear and nose piercing, sharing of razors, etc.	30-80 days	Fatigue, jaundice, persistent low grade fever, rash and abdominal pain. It can cause cirrhosis and possibly liver cancer.	Hepatitis B surface antigen (HBSAg), ELISA	Adefovir or Entecavir
Genital herpes	Herpes simplex virus	Genital secretions (through contact with genitalia).	–	Vesiculopustular lesions followed by clusters of painful erythematous ulcers over external genitalia and peri-anal regions, vaginal and urethral discharge and swelling of lymph nodes.	Antigen detection, PCR, nucleic acid hybridisation	Acyclovir, valacyclovir or famciclovir
Genital warts	Human papilloma virus	Sexual intercourse	–	Benign, hard outgrowths with horny surface (warts) over the skin and mucosal surface of external genitalia and peri-anal area.	Antibody detection, culture and DNA hybridisation	Cryosurgery is used in removal of warts. *Podophyllum* preparations and podofilox are useful in treatment. Imiquimod, an interferon inducer, is also useful.
III. STDs caused by Chlamydia						
Chlamydiasis	*Chlamydia trachomatis*	Sexual contact	1 week	Urethritis, epididymitis, mucopurulent, cervicitis, inflammation of fallopian tubes, proctitis (rectal pain with mucus and occasional bleeding), etc.	Gram staining of discharge, antigen detection, nucleic acid hybridisation	Antibiotics like tetracycline, erythromycin and rifampacin
IV. STDs caused by Protozoans						
Trichomoniasis	*Trichomonas vaginalis*	Sexual intercourse	–	In females, it causes vaginitis with foul smelling, yellow vaginal discharge and burning sensation. In males, it causes urethritis, epididymitis and prostatitis resulting in pain and burning sensation.	Gram staining of discharge, antigen detection, nucleic acid hybridisation	Metronidazole
Amoebiasis	*Entamoeba histolytica*	Contaminated food and water, sometimes through sexual contact	–	The patient passes blood along with faeces and feels pain in abdomen.	–	Antiamoebic tablets

INFERTILITY

- Inability to conceive or produce children inspite of unprotected sexual intercourse is called **infertility**.
- Infertility occurs due to defects in the male or in the female or in both.
- In case the treatment of cause of infertility is not possible, the couple can be assisted to have children through certain special techniques called **assisted reproductive technologies (ART)**. Some important techniques of ART are:

WHO AM I ...

"I am a technique in which semen is collected artificially and introduced either into vagina or in the uterus."

...search me ☺

Test Tube Baby

- This method involves *in vitro* fertilisation (IVF), *i.e.*, fertilisation of male and female gametes outside the body in almost similar conditions as that *in vivo* followed by **embryo transfer (ET).**
- In this method, ova from wife/donor female and sperms from husband/donor male are induced to form zygote in laboratory.
- Embryo upto 8 blastomeres is transferred into the fallopian tube (**ZIFT - Zygote Intra Fallopian Transfer**) to complete its further development.
- If the embryo is with more than 8 blastomeres, then it is transferred into uterus (**IUT - Intra Uterine Transfer**) to complete its further development.

Artificial Insemination (AI) Technique

- AI technique is used in case of infertility of male partner, where the husband is either unable to inseminate the female or has very low sperm count in the ejaculation.
- In this technique, the semen collected either from the husband or a healthy donor is artificially introduced into the vagina or uterus (**IUI - Intra-Uterine Insemination**) of the female.

Gamete Intra Fallopian Transfer (GIFT)

- This method is used in females who cannot produce ova but can provide suitable environment for fertilisation and further development of embryo in the oviducts.
- In this technique, both sperms and unfertilised oocytes are transferred into fallopian tubes of female and fertilisation takes place inside the body of female.

Intracytoplasmic Sperm Injection (ICSI)

- In this technique, one single spermatozoon or even a spermatid is injected directly into the cytoplasm of an oocyte by micropuncture of the zona pellucida.
- The embryo is later transferred by **ZIFT** or **IUT** in woman.

DETECTION OF FETAL DISORDERS

- The fetal disorders during early pregnancy can be detected by following techniques:

Amniocentesis

- Amniocentesis is a fetal sex determination and disorder test based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.
- At the early stage of pregnancy (14th or 15th week), the location of the fetus and placenta is determined by sonography.
- Then a small amount of amniotic fluid is drawn by passing a special surgical syringe needle into the abdominal wall and uterine wall into the amniotic sac containing amniotic fluid.
- The amniotic fluid contains cells from fetus skin and respiratory tract. These cells are cultured and are used to determine chromosomal abnormalities (Down's syndrome, Klinefelter's syndrome, etc.) and metabolic disorders (phenylketonuria, sickle cell anaemia, etc.) of the fetus.
- Unfortunately, this useful technique, is being misused to kill the normal female fetuses. It has been **legally banned for the determination of sex** to avoid female feticide.

Non-invasive techniques

- One of the widely used non-invasive technique to determine fetal condition is **ultrasound imaging.**
- Another non-invasive technique is based on the fact that a few fetal blood cells leak across the placenta into the mother's blood stream. A blood sample from the mother provides enough fetal cells that can be tested for genetic disorders.

Fetoscopy

- Fetoscopy is another technique in which a needle-thin tube containing a viewing scope is inserted into the uterus, giving the physician a direct view of the fetus.

INTEXT PRACTICE QUESTIONS

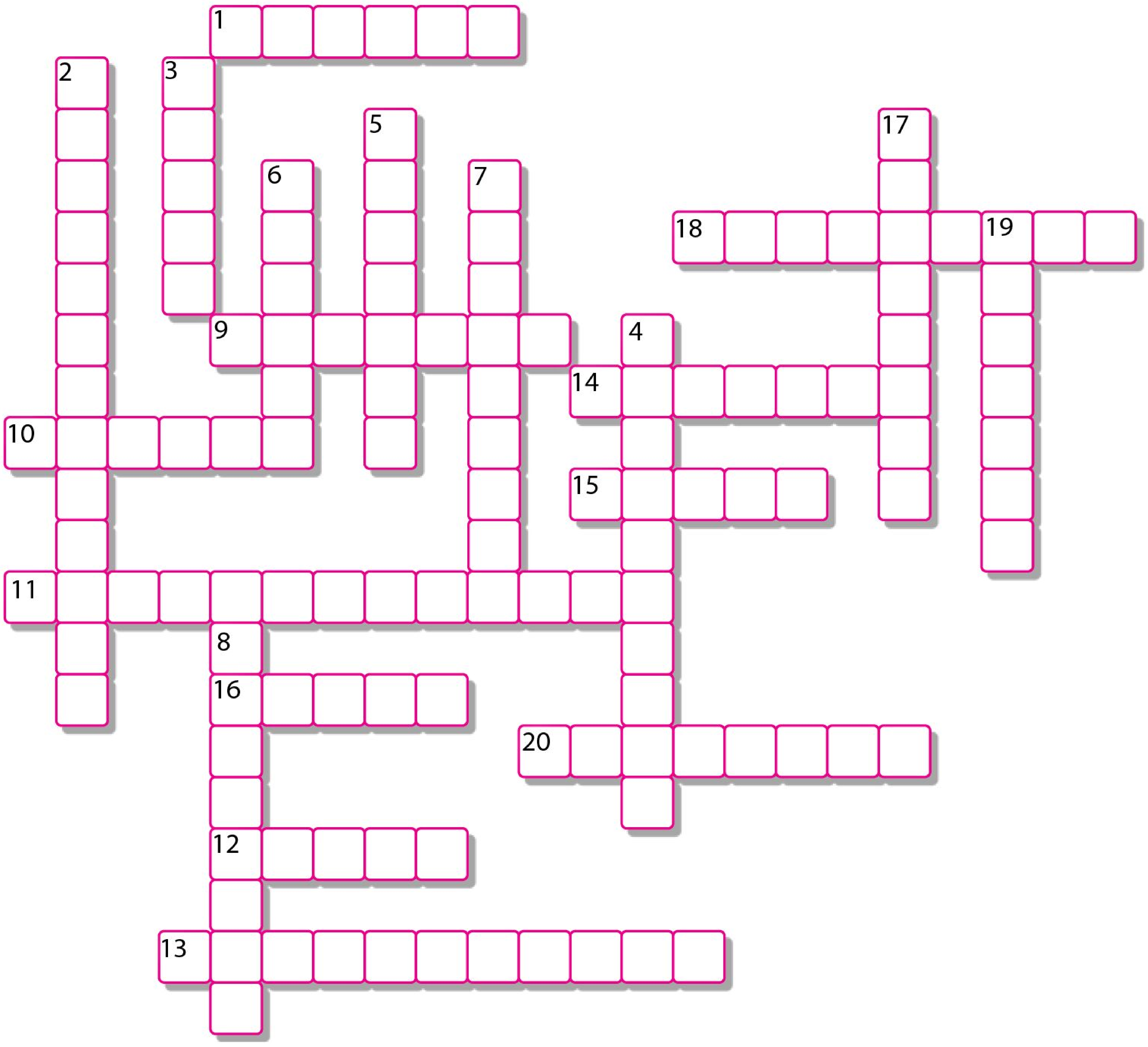
5. What is the non-steroidal chemical preparation of the contraception pill 'Saheli'?

6. By which method both sperm and unfertilised oocytes are transferred into fallopian tube of female?

CROSSWORD

Readers are requested to send their responses of crossword to be the winner.

Read the given clues and solve the crossword with correct words.



ACROSS

1. Receives semen from male reproductive system.
9. Carries semen and urine outside the body.
10. Produces male sex cell (sperm).
11. This is where fertilisation of female sex cell normally takes place.
12. Produces and stores female sex cell (egg).
13. Cells that secrete androgens.
14. Hormone involved in parturition.
15. Stage when embryo have differentiated organs and organ system.
16. Male germ cell.
18. Period of production of milk at the end of pregnancy.
20. Finger-like structure present above urethral opening.

DOWN

2. Produces fluid that mixes with sperm to form semen.
3. Delivers semen to the female reproductive system.
4. Coiled structure that stores sperm.
5. Sac that contains testes.
6. It is also called as womb.
7. Another name for the vas deferens.
8. Hormone secreted by follicular cells.
17. Functional unit between developing embryo and maternal body.
19. Last part of oviduct.

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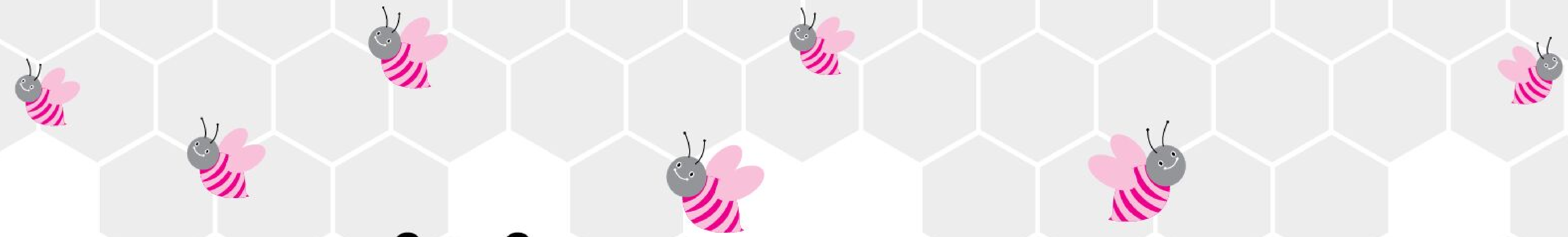


BIO BUZZ

The given honeycomb contains 7 letter words for the given clues. Find the words for the given clues and shade the center letter of each word. [**Hint :** The shaded letter F and the six letters surrounding it spell a word that matches one of the clues below].

1. Preserved remains _________

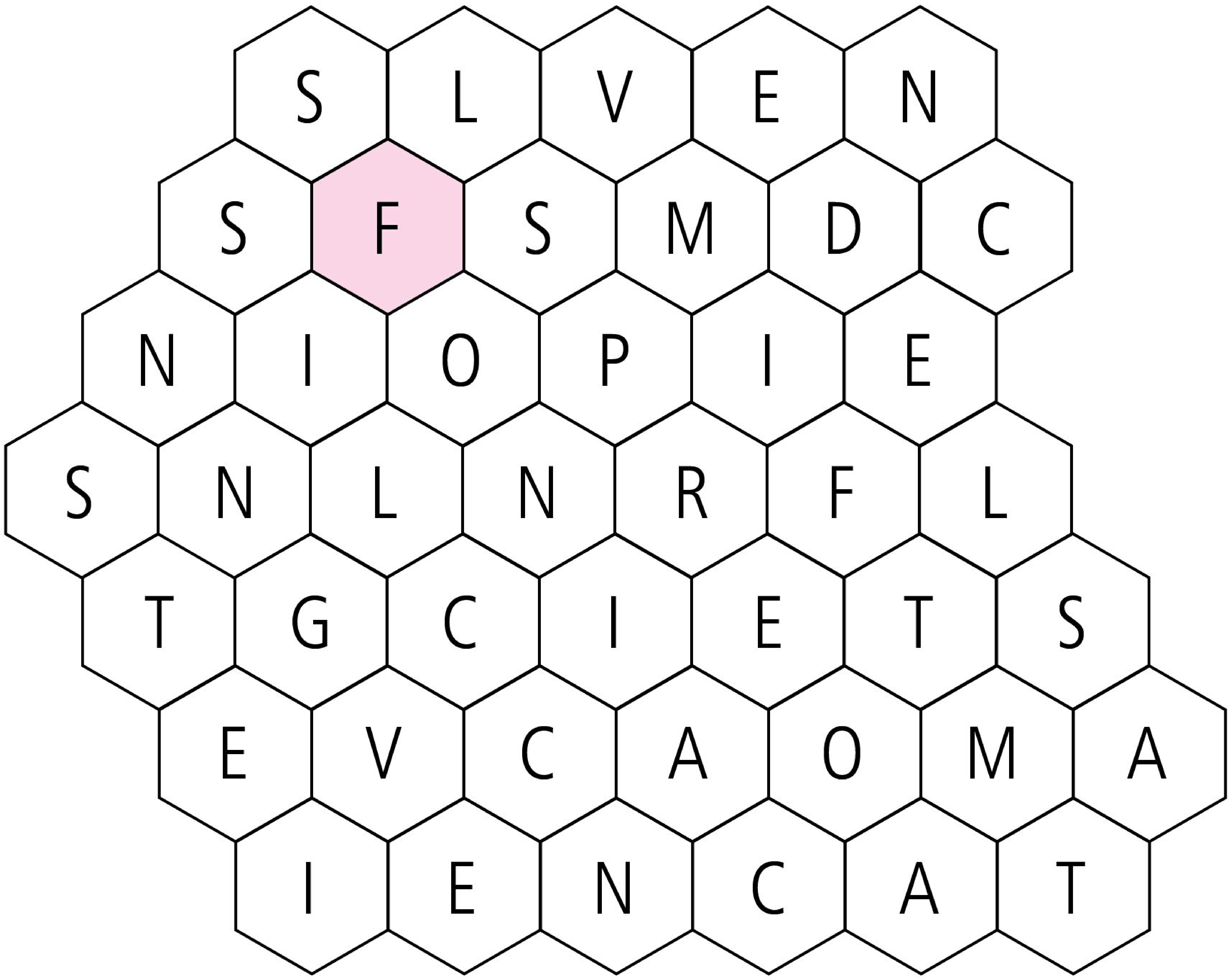
2. Identical copy of any organism _________

3. Regulate gas-exchange in leaves _________

4. Able to produce offsprings _________

5. Restricted to particular area _________

6. Antibody provoking agent _________



S L V E N

S F S M D C

N I O P I E

S N L N R F L

T G C I E T S

E V C A O M A

I E N C A T

*Please send entries of solutions both with words and scanned copy of the grid within 10th of every month.

Class XII

Monthly test drive

This specially designed column enables students to self analyse their extent of understanding of specific chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160 **Time :** 40 Min.

Series II Human Reproduction

1. Which is not a part of male accessory gland?
(a) Penis (b) Prostate
(c) Seminal vesicle (d) Bulbourethral gland

2. Read the given characteristics and identify the reproductive organ.
(i) It is a paired structure.
(ii) It is present on either side of male urethra.
(iii) It helps in lubrication of penis.
(a) Seminal vesicle (b) Bartholin gland
(c) Bulbourethral gland (d) Prostate

3. Select the correct sequence of phases of menstrual cycle.
(a) Menstruation, Secretory, Follicular
(b) Menstruation, Follicular, Luteal
(c) Follicular, Menstruation, Luteal
(d) Menstruation, Luteal, Follicular

4. In human females, ova are produced in
(a) ovarian follicles (b) oviduct
(c) uterus (d) vagina.

5. Select the correct match of terms given in column I with their description given in column II.

	Column I		Column II
A.	Parturition	I.	Duration between pregnancy and child birth
B.	Ovulation	II.	Embedding of blastocyst in the endometrium
C.	Gestation	III.	Childbirth
D.	Implantation	IV.	Release of egg from Graafian follicle

(a) A-I; B-III; C-II; D-IV
(b) A-III; B-I; C-IV; D-II
(c) A-III; B-IV; C-I; D-II
(d) A-III; B-II; C-I; D-IV

6. Which of the following hormones attain a peak level in the middle of menstrual cycle?
(a) LH and progesterone
(b) FSH and progesterone
(c) FSH and LH
(d) Estrogen and progesterone

7. Spermatozoa are nourished during their development by
(a) Sertoli cells
(b) interstitial cells
(c) connective tissue cells
(d) none of these.

8. The head of mature mammalian sperm is made of
(a) the corpus luteum of the uterus
(b) elongated nucleus covered by acrosome
(c) two centrioles and an axial filament
(d) nucleus, acrosome, cytoplasm and mitochondrial sheath.

9. Which of the following is incorrect regarding menstrual cycle?
(a) During menstrual phase, the production of LH from pituitary gland is considerably reduced.
(b) Primary follicle changes into Graafian follicle in proliferative phase of menstrual cycle.
(c) LH surge is observed during secretory phase of menstrual cycle.
(d) FSH and LH increases gradually, that stimulate the development of Graafian follicles.

10. Fluid filled cavity, antrum is present in
(a) primary follicle (b) secondary follicle
(c) tertiary follicle (d) none of these.

11. Which of the following part facilitates sperm motility?
(a) Head (b) Tail
(c) Whole sperm (d) Both (a) and (b)

12. In most mammals, the testes are located in
(a) abdominal cavity
(b) thoracic cavity
(c) extra-abdominal cavity
(d) pericardial cavity.

13. Which of the following statements is incorrect?
(a) Mammary gland is characteristic of all female mammals.
(b) Male germ cells of seminiferous tubules undergo meiotic division to form sperms.
(c) Testes are covered by loose fold of skin called foreskin.
(d) Each ovary is connected to pelvic wall and uterus by ligaments.

14. At the time of implantation, the human embryo is called
(a) zygote
(b) blastocyst
(c) embryo
(d) fetus.

15. In absence of fertilisation, corpus luteum
(a) stops secreting progesterone
(b) degenerates
(c) starts producing progesterone
(d) none of these.

16. Read the given statements and select the correct option.
Statement I : Uterus opens into cervix through vagina.
Statement II : The cavity of cervix along with vagina forms birth canal.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

17. Match the items given in column I with those in column II and select the correct option given below.

	Column I		Column II
A.	Proliferative phase	(i)	Breakdown of endometrial lining
B.	Secretory phase	(ii)	Follicular phase
C.	Menstruation	(iii)	Luteal phase

	A	B	C
(a)	(iii)	(ii)	(i)
(b)	(i)	(iii)	(ii)
(c)	(ii)	(iii)	(i)
(d)	(iii)	(i)	(ii)

18. Implantation in human female occurs in stage of
(a) morula, 8-16 celled stage
(b) blastocyst
(c) 16 celled embryo
(d) blastocyst without trophoblast.

19. Ovaries are the A sex organs which produce ovum and hormone called B. Here A and B refers to

	A	B
(a)	secondary	testosterone
(b)	secondary	inhibin
(c)	primary	estrogen
(d)	primary	testosterone.

20. Progesterone level falls during
(a) gestation
(b) menopause
(c) lactation
(d) menstruation.

21. Match the columns and select the correct option.

	Column I		Column II
A.	FSH	1.	Prepares endometrium for implantation
B.	LH	2.	Develops female secondary sexual characters
C.	Progesterone	3.	Contraction of uterine wall
D.	Estrogen	4.	Development of corpus luteum
E.	Oxytocin	5.	Maturation of Graafian follicle

(a) A-5, B-4, C-1, D-2, E-3
(b) A-4, B-5, C-2, D-1, E-3
(c) A-4, B-3, C-2, D-5, E-1
(d) A-5, B-3, C-2, D-4, E-1

22. Read the following statements about menstrual cycle and select the correct ones.
(i) Lack of menstruation may be indicative of pregnancy.
(ii) The changes in the ovary and the uterus are induced by changes in the levels of ovarian hormones only.
(iii) LH surge induces ovulation.
(iv) If fertilisation occurs, corpus luteum degenerates immediately.
(a) (i) and (ii)
(b) (ii) and (iii)
(c) (i) and (iii)
(d) (ii) and (iv)

IMPORTANT DAYS OF THE MONTH (MAY)

1 May	International Labour Day or May Day
2 May	World Asthma Day (First Tuesday of May)
4 May	World Laughter Day (First Sunday of May)
8 May	World Red Cross Day, World Thalassaemia Day
12 May	International Nurses Day
17 May	World Hypertension Day, National Endangered Species Day (Third Friday in May)
18 May	World AIDS Vaccine Day
22 May	International Day for Biological Diversity
31 May	Anti-Tobacco Day

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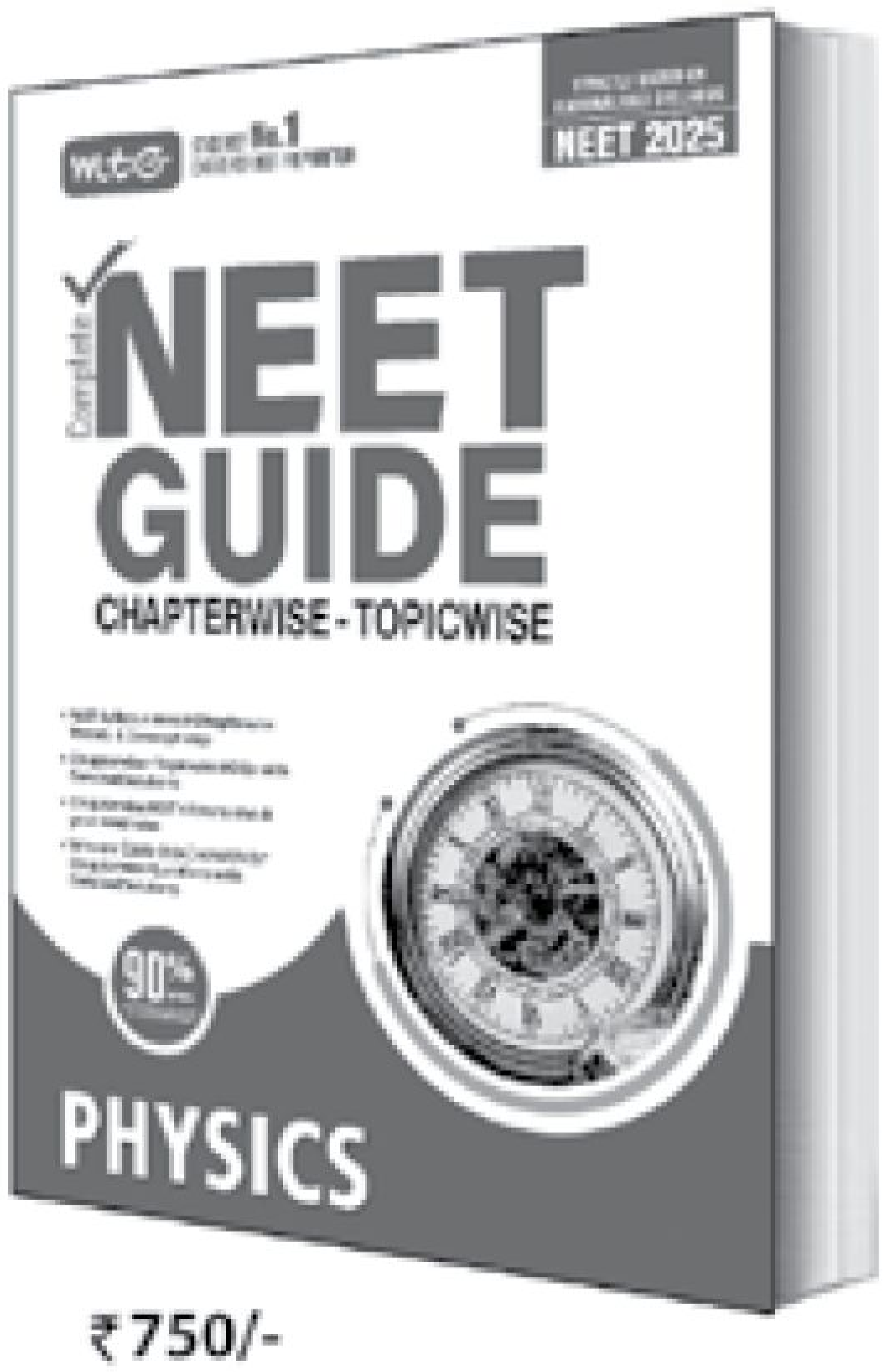
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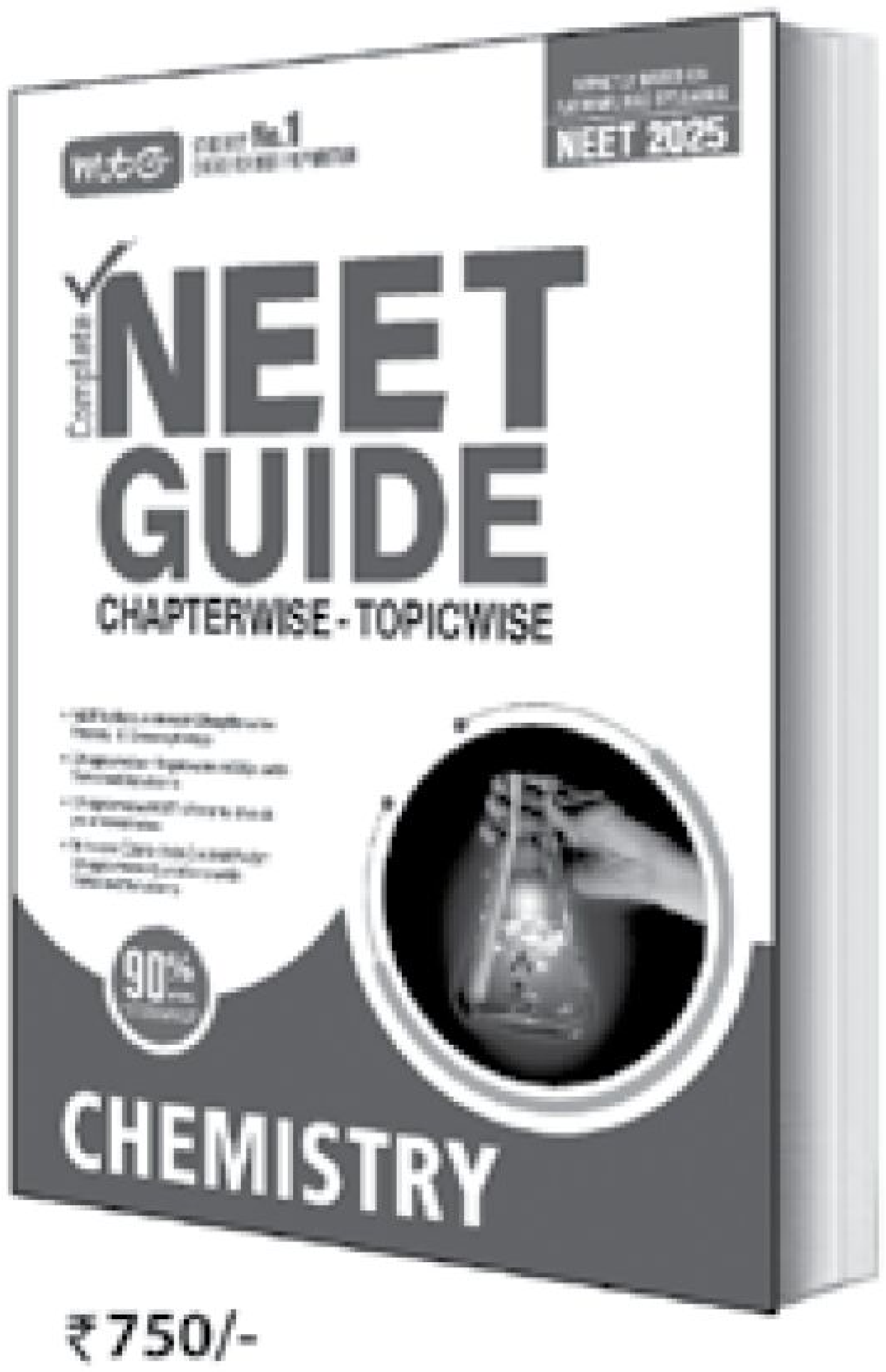
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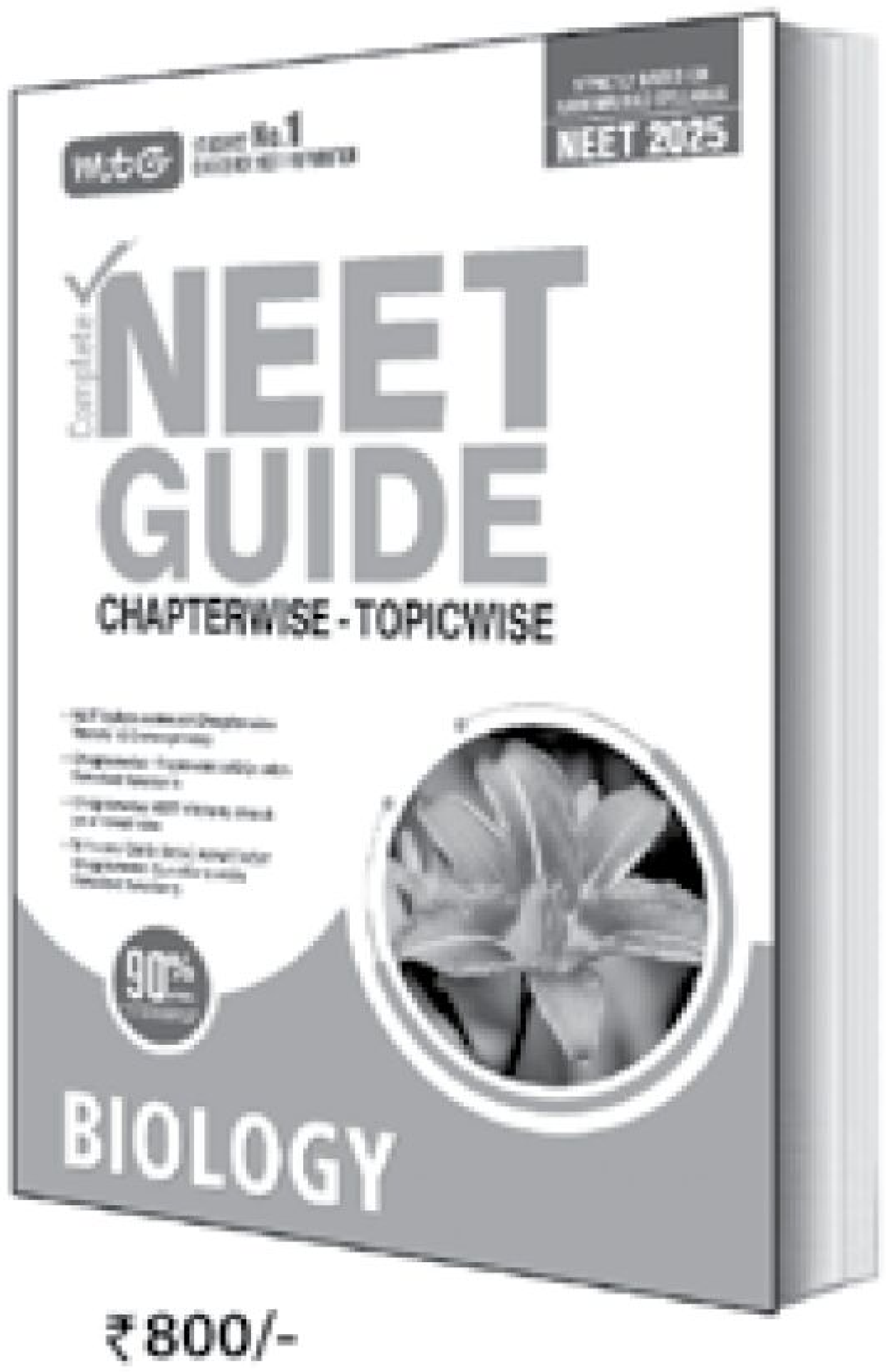
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23. During menstrual cycle, ovulation in the human female normally takes place
(a) at the mid secretory phase
(b) at the end of the proliferative phase
(c) just before the end of the secretory phase
(d) at the beginning of the proliferative phase.

24. At what temperature, maturation of sperm take place in mammals?
(a) Equal to that of body
(b) Higher than that of body
(c) Lower than that of body
(d) At any temperature

25. Select the correct option describing gonadotropin activity in a normal pregnant female.
(a) High level of FSH and LH stimulates the thickening of endometrium.
(b) High level of FSH and LH facilitates implantation of the embryo.
(c) High level of hCG stimulates the synthesis of estrogen and progesterone.
(d) High level of hCG stimulates the thickening of myometrium.

26. Select the incorrect statement.
(a) LH and FSH decrease gradually during the follicular phase.
(b) LH triggers secretion of androgens from the Leydig cells.
(c) FSH stimulates the Sertoli cells which help in spermiogenesis.
(d) LH triggers ovulation in ovary.

27. Match the columns and select the correct option.

	Column I		**Column II**
A.	Mons pubis	1.	Fleshy folds of tissue surrounding vagina
B.	Labia majora	2.	Cushion of fatty tissue converted by skin and pubic hair
C.	Labia minora	3.	Membrane partially covered the opening of vagina
D.	Hymen	4.	Paired folds of tissue under the labia majora

(a) A-1, B-2, C-3, D-4
(b) A-2, B-1, C-4, D-3
(c) A-3, B-1, C-2, D-4
(d) A-4, B-3, C-1, D-2

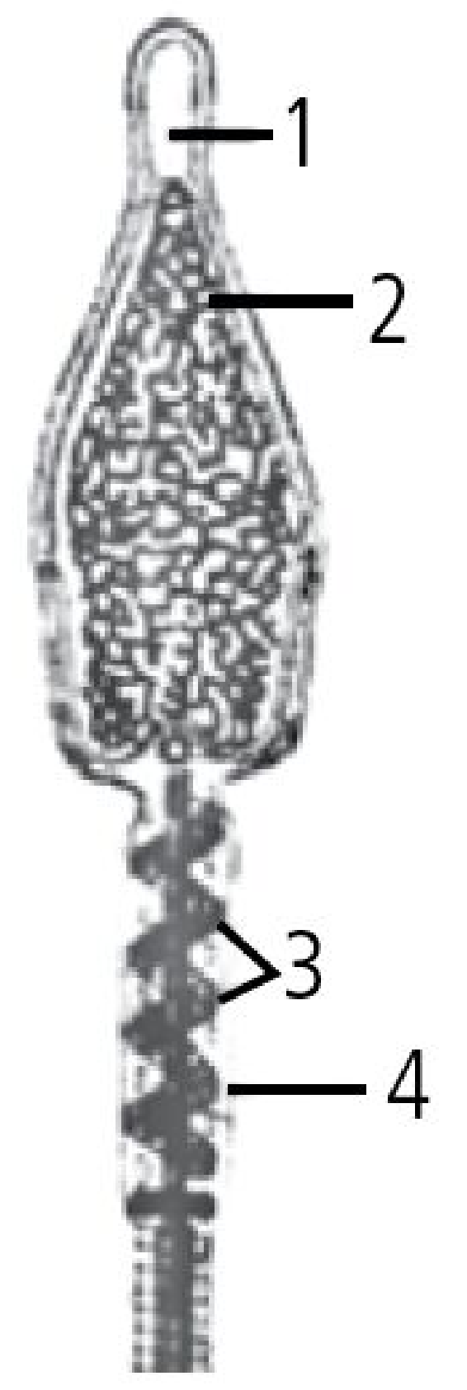
28. The fusion of male and female gamete in human occurs at
(a) infundibulum and ampulla
(b) isthmus and fundus
(c) ampullary region
(d) cervix and fundus.

29. The function of the secretion of prostate gland is to
(a) inhibit sperm activity
(b) attract sperms
(c) stimulate sperm activity
(d) none of these.

30. Which one of the following statements with regard to embryonic development in humans is correct?
(a) During cleavage, meiotic division starts as the zygote moves through oviduct.
(b) As a result of the cleavage, each daughter cell is formed called trophoblast.
(c) In blastocyst stage, an inner group of cells attached to trophoblast called blastomeres.
(d) Cleavage division results in a solid ball of 8-16 cells called morula.

31. In adult human females, oxytocin
(a) stimulates pituitary to secrete vasopressin
(b) causes strong uterine contractions during parturition
(c) is produced by maternal pituitary
(d) stimulates growth of mammary glands.

32. In the given diagram of mature human sperm, identify the parts named 1-4 and select the correct statement.



(a) 1 produce energy for movement of tail.
(b) 2 contains an elongated haploid nucleus.
(c) 3 is filled with enzymes for fertilisation of ovum.
(d) 4 envelops the whole body of sperm.

TRIO

The same THREE LETTERS will complete these four words.

Can you find the three-letter sequence?

AT — — — UATED
HYPER — — — SION
CARO — — — E
— — — TACLES

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Winners' names will be published in next issue.

33. **Assertion (A) :** Placenta acts as a major endocrine tissue during pregnancy.
Reason (R) : In mammals, foetus supply oxygen and nutrients to the mother.
(a) Both (A) and (R) are correct and (R) is the correct explanation of (R).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is incorrect.
(d) (A) is incorrect but (R) is correct.

34. The testes in humans are situated outside the abdominal cavity inside a pouch called scrotum. The purpose served is for
(a) maintaining the scrotal temperature lower than the internal body temperature.
(b) escaping any possible compression by the visceral organs.
(c) providing more space for the growth of epididymis.
(d) providing a secondary sexual feature for exhibiting the male sex.

35. Which of the following organ is differentiated during first month of pregnancy?
(a) Heart (b) Skin
(c) Brain (d) Neural tube

36. Choose the correct statement regarding spermatogenesis.
(a) The growth of spermatogonia into secondary spermatocyte through mitosis.
(b) The formation of spermatogonia from gonocytes through mitosis.
(c) The formation of spermatids from secondary spermatocytes occurs through meiosis.
(d) The formation of oogonia from the spermatocytes through meiosis.

37. Epididymis lies in between
(a) vasa efferentia and rete testis
(b) vasa efferentia and vas deferens
(c) vas deferens and ejaculatory duct
(d) seminiferous tubules and rete testis.

38. A woman was pregnant and told that due to some complication her placenta is not functioning properly. What will happen if the placenta fails to function during her gestation?
(a) There would be no effect on the continuation of pregnancy.
(b) The pregnancy would continue with the delivery of a premature foetus.
(c) The development of the foetus will be affected due to not getting sufficient oxygen and nutrients.
(d) The corpus luteum would continue producing hormone as an alternative source until birth.

39. Which portion of the uterus is shed during menstruation?
(a) Perimetrium (b) Endometrium
(c) Myometrium (d) Both (b) and (c)

40. 'X' is not attached to the female gonad but have a part that is involved in receiving the eggs after their maturation. Identify 'X'.
(a) Vagina (b) Uterus
(c) Oviduct (d) Cervix ☺☺

INFO SHOTS

What Are the Benefits of a Vegan Diet?

Numerous studies have connected plant-based diets with a range of health benefits, including prevention of diabetes, improvement of cholesterol levels, promotion of healthy weight loss, decrease in risk of cardiovascular disease and protection against certain kinds of cancers.

Additionally, veganism can have a positive impact on the planet by helping reduce pollutants that affect global temperatures. In 2021, the Intergovernmental Panel on Climate Changes estimated that if the world's population adopted a completely plant-based diet, global carbon dioxide(CO_2) emissions could decrease by almost 8 billion tons per year by 20250. That's because raising live-stock - particularly cows for meat and dairy - is currently responsible for an estimated 14.5 per cent of greenhouse gas emissions each year, according to the New York Times. That's roughly equivalent to all the emissions from cars, trucks, airplanes and boats combined. Other estimates put it even higher.

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Quiz CLUB

Unlock Your Knowledge!

1. Which of the following represents Phylum Arthropoda?
(a) Cuttle fish (b) Silver fish
(c) Puffer fish (d) Flying fish

2. Which of the following is most common type of ovule?
(a) Orthotropous (b) Anatropous
(c) Amphitropous (d) Hemintropous

3. Vessels are not found in the wood of
(a) pine (b) eucalyptus
(c) teak (d) sheesham.

4. Which part of the tobacco plant is infected by *Meloidogyne incognita*?
(a) Leaf (b) Root
(c) Stem (d) Flower

5. What is the direction of movement of sugars in phloem?
(a) Non-multidirectional (b) Upward
(c) Downward (d) Bidirectional

6. Which of the following is mainly produced by the activity of anaerobic bacteria on sewage?
(a) Mustard (b) Marsh gas
(c) Laughing gas (d) Propane

7. When is International Day for Biological Diversity is celebrated?
(a) 23rd May (b) 10th May
(c) 30th May (d) 22nd May

8. Which of the following state named all its tourist resorts after birds?
(a) Bihar (b) Uttarakhand
(c) Assam (d) Haryana

9. Anoxygenic photosynthesis is characteristic of
(a) *Spirogyra* (b) *Chlamydomonas*
(c) *Ulva* (d) *Rhodospirillum*.

10. Who discovered the jumping gene in 1951?
(a) Hermun Muller (b) Alexander Rich
(c) Barbara Mc Clintock (d) Levan

11. Which of the following flowers show radial symmetry?
(a) *Cassia* (b) *Brassica*
(c) *Irifolium* (d) *Pisum*

12. Japanese encephalitis is transmitted by
(a) housefly (b) tse tse fly
(c) sand fly (d) mosquito.

13. What is the average cell cycle span for a mammalian cell?
(a) 72 hours (b) 24 hours
(c) 36 hours (d) 12 hours

14. Who discovered the natural parthenogenesis?
(a) Charles Bonnet (b) Steno
(c) Karl Ernst von Baer (d) Swammerdam

15. Which of the following are not polymeric?
(a) Nucleic acid (b) Proteins
(c) Polysaccharides (d) Lipids

Answer Key

☺☺
1. (b) **2.** (b) **3.** (a) **4.** (b) **5.** (d)
6. (b) **7.** (d) **8.** (d) **9.** (d) **10.** (c)
11. (b) **12.** (d) **13.** (b) **14.** (a) **15.** (d)

TRIO

ANSWERS APRIL 2025

The three letter sequence is **TAS**.

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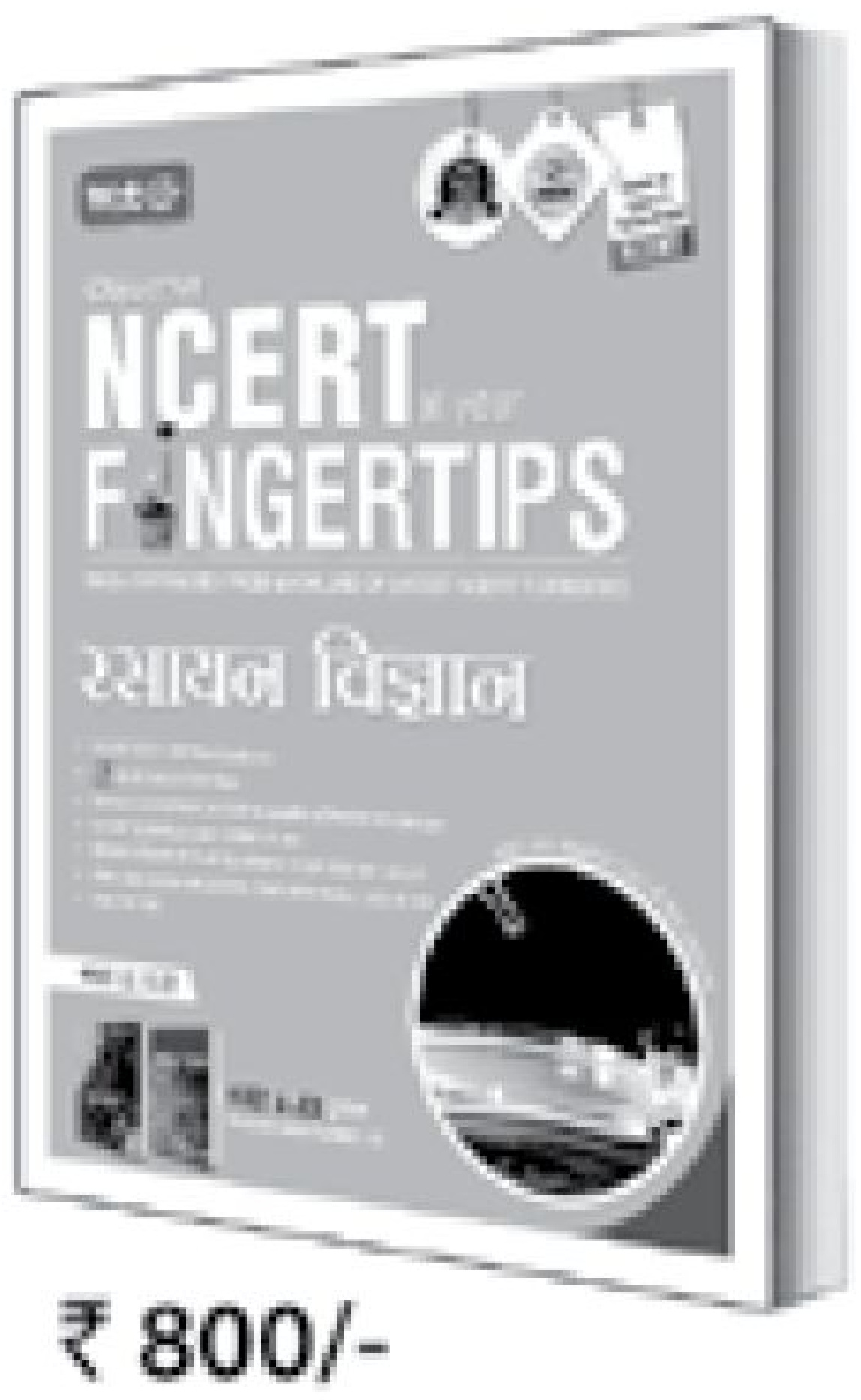

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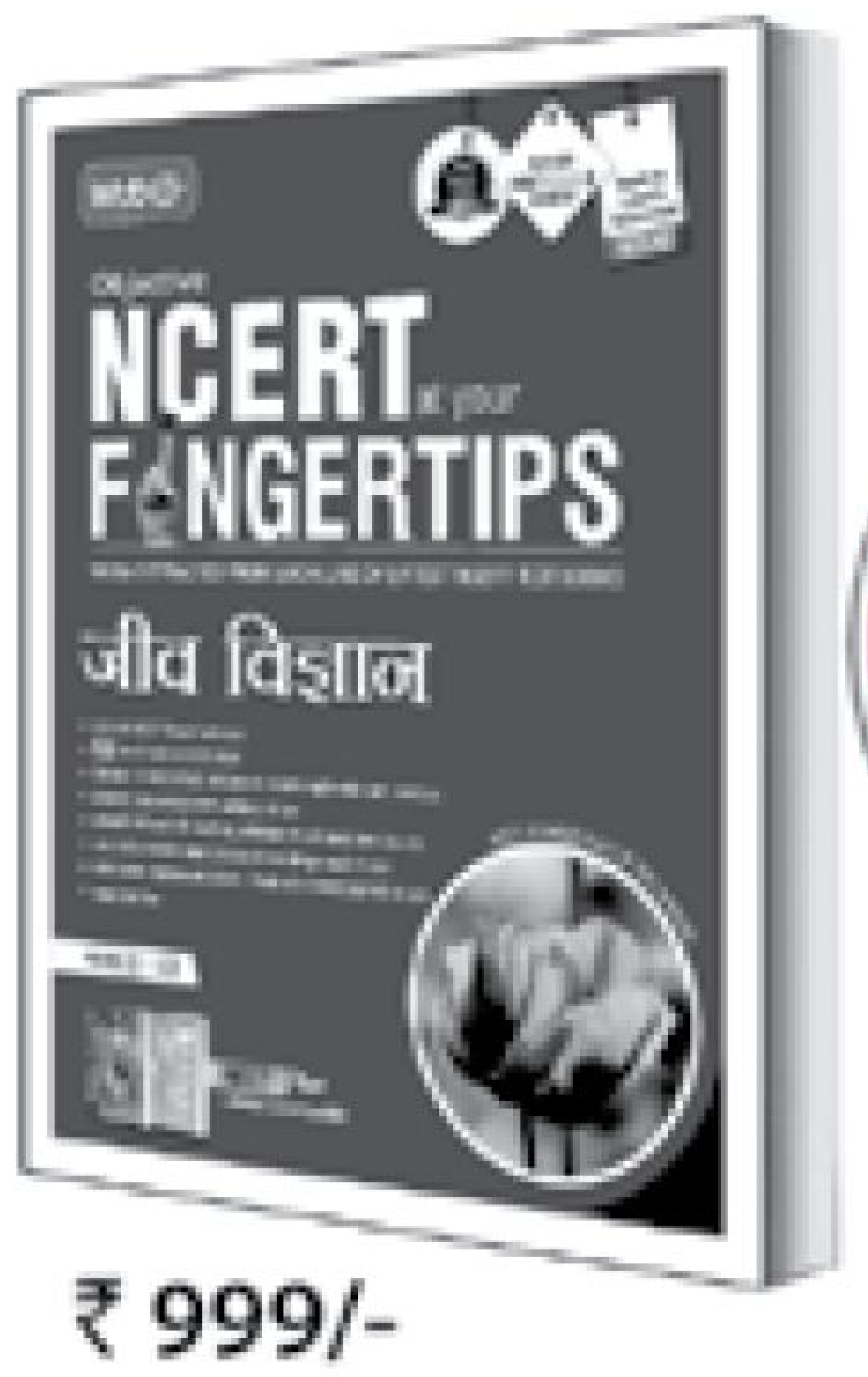

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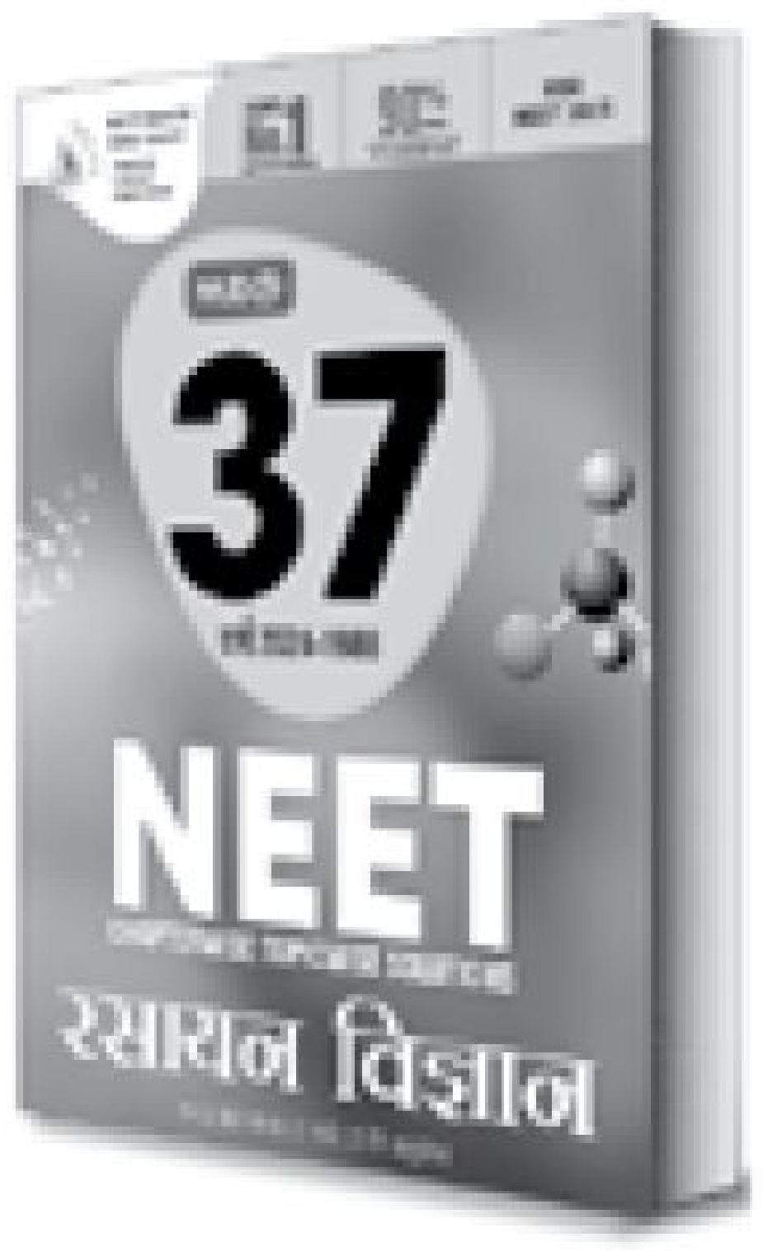

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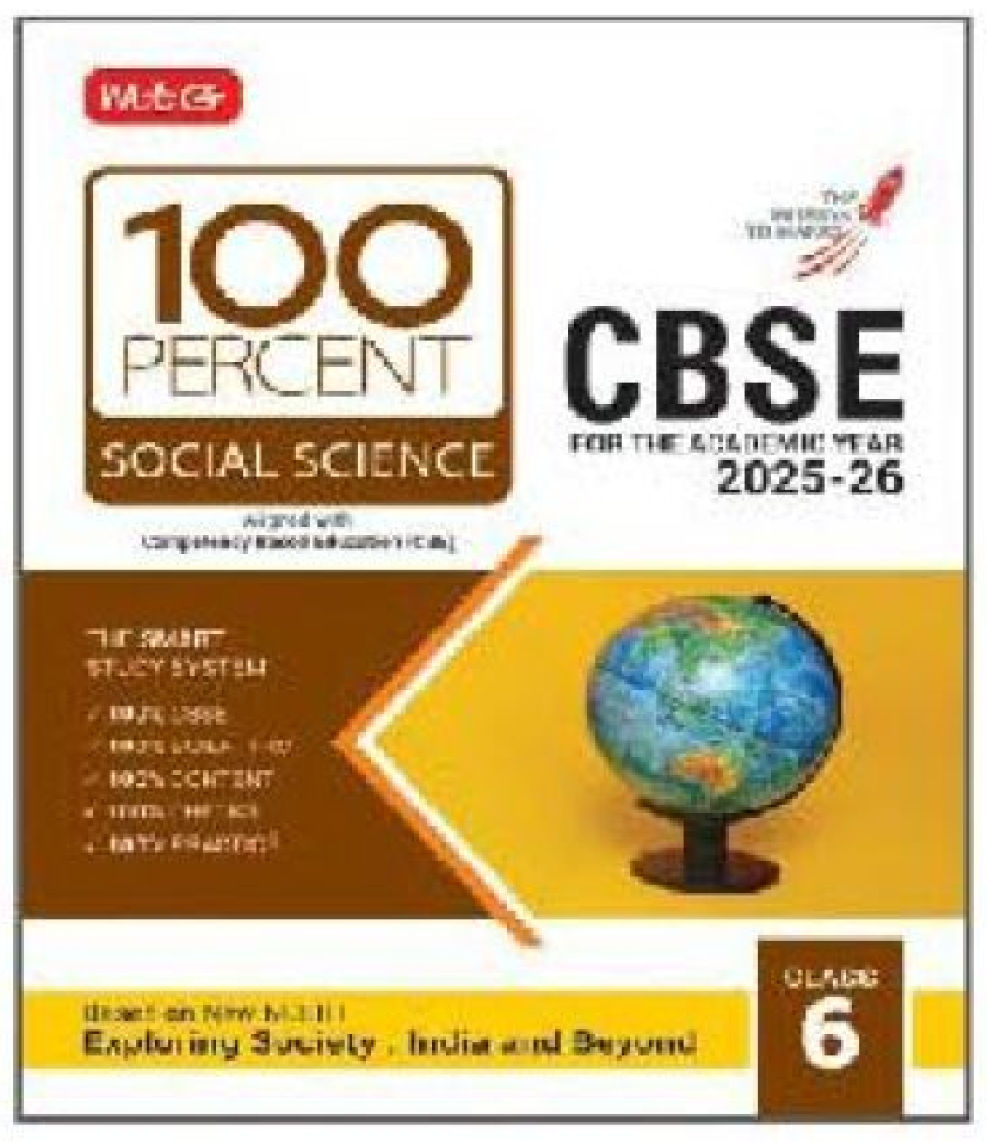
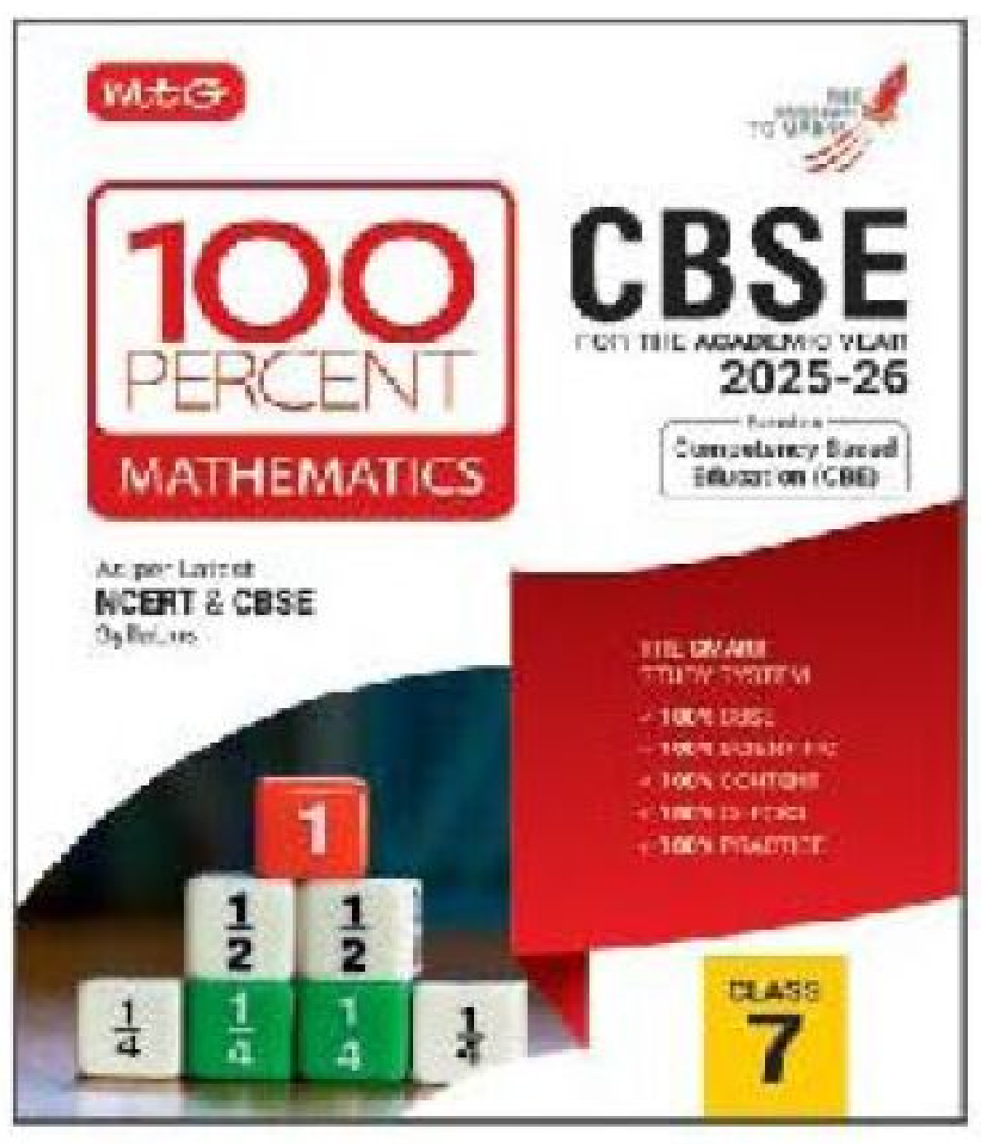

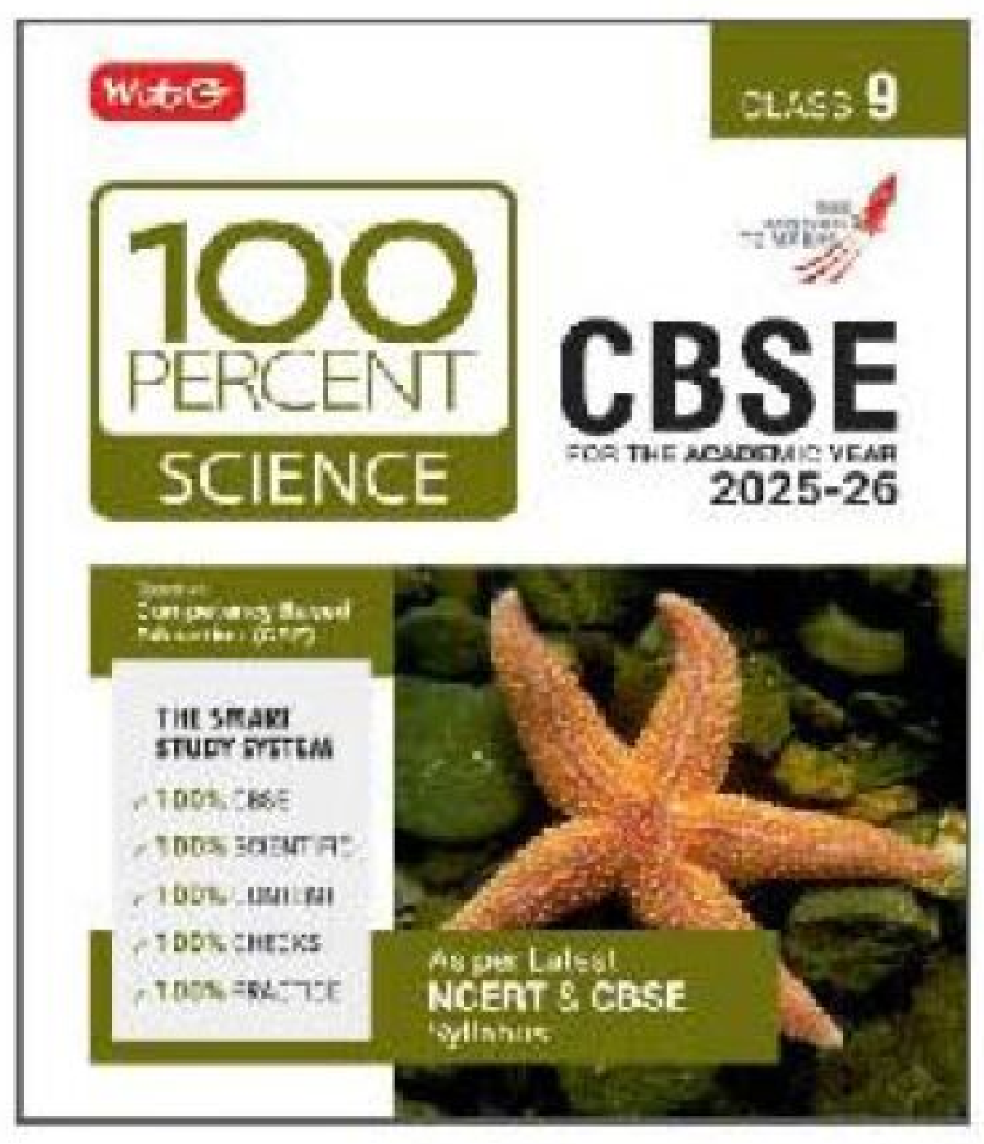
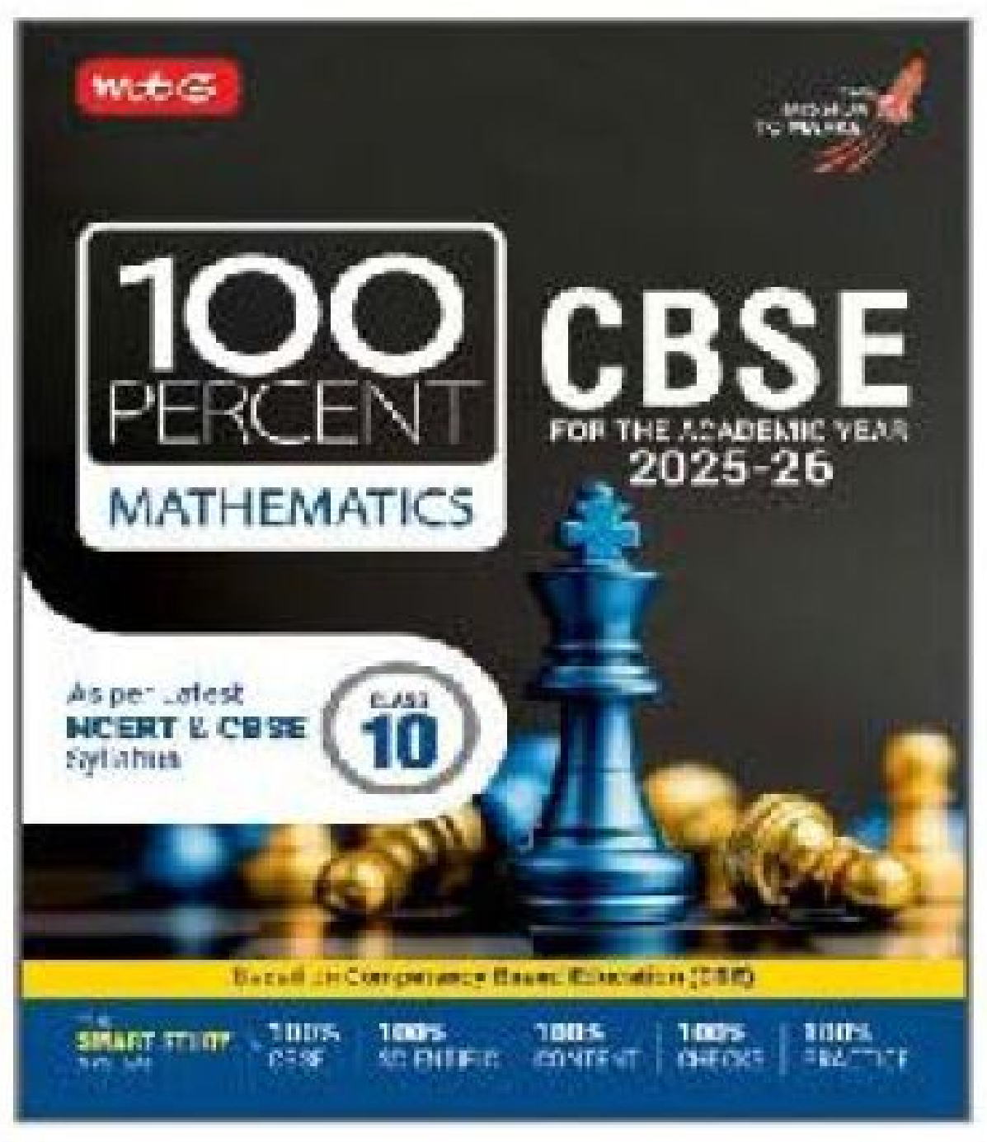
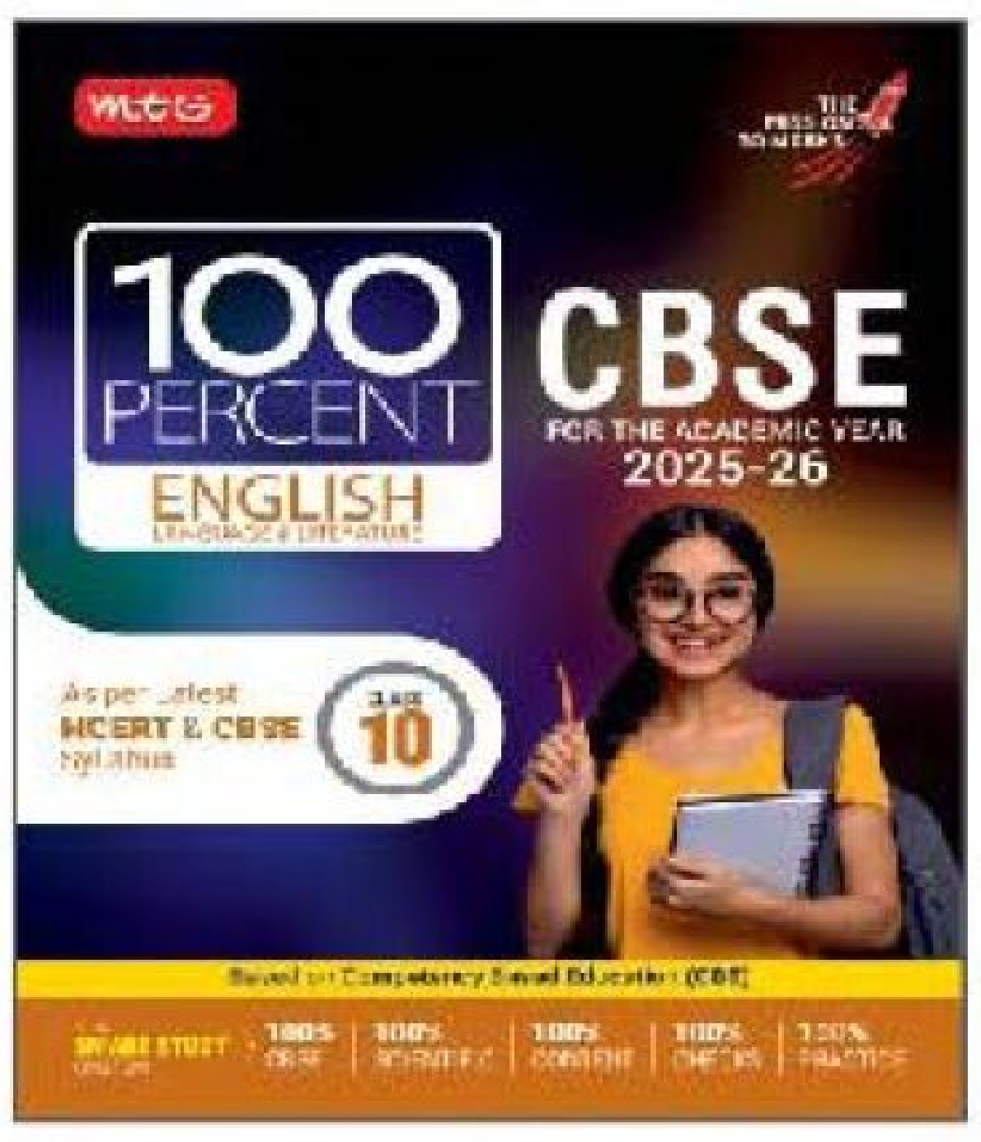
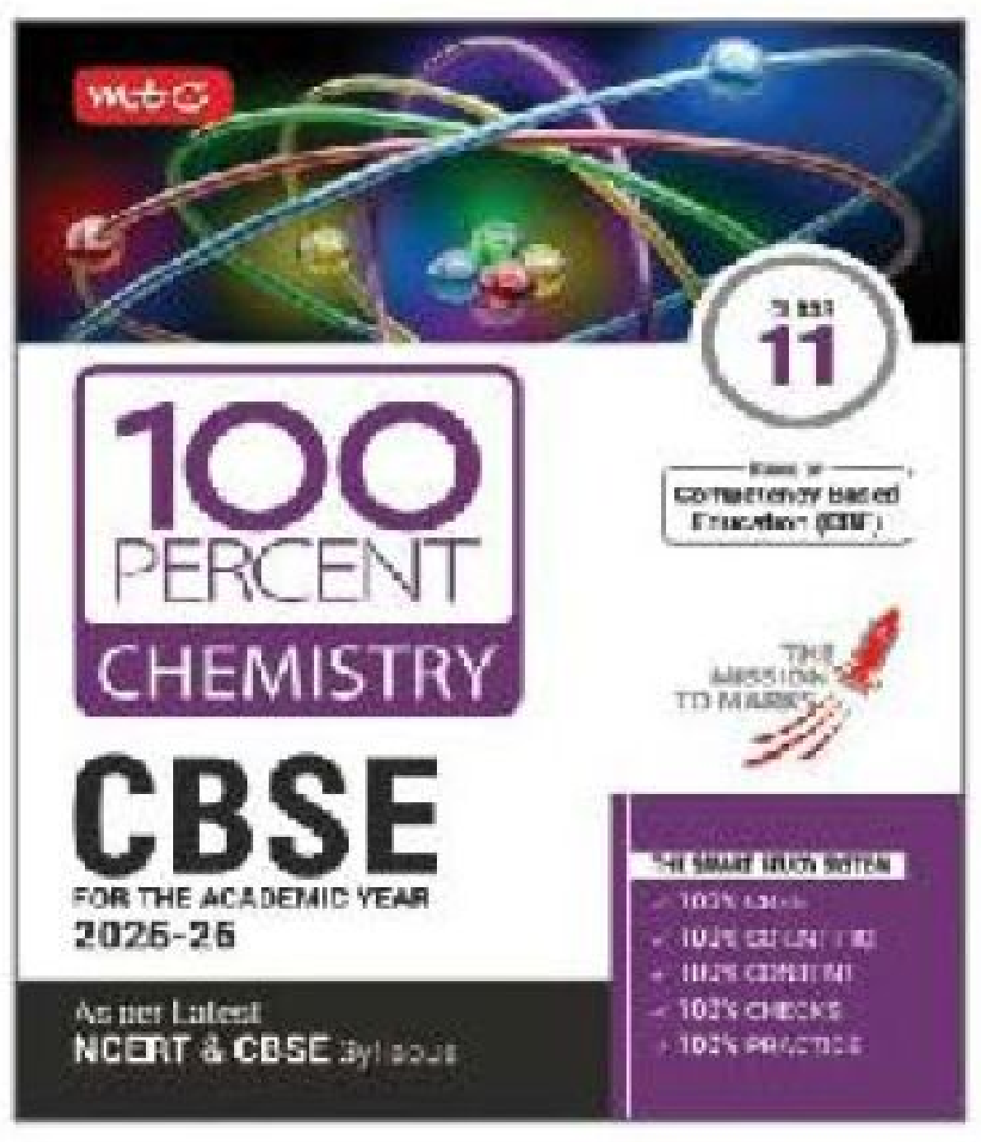
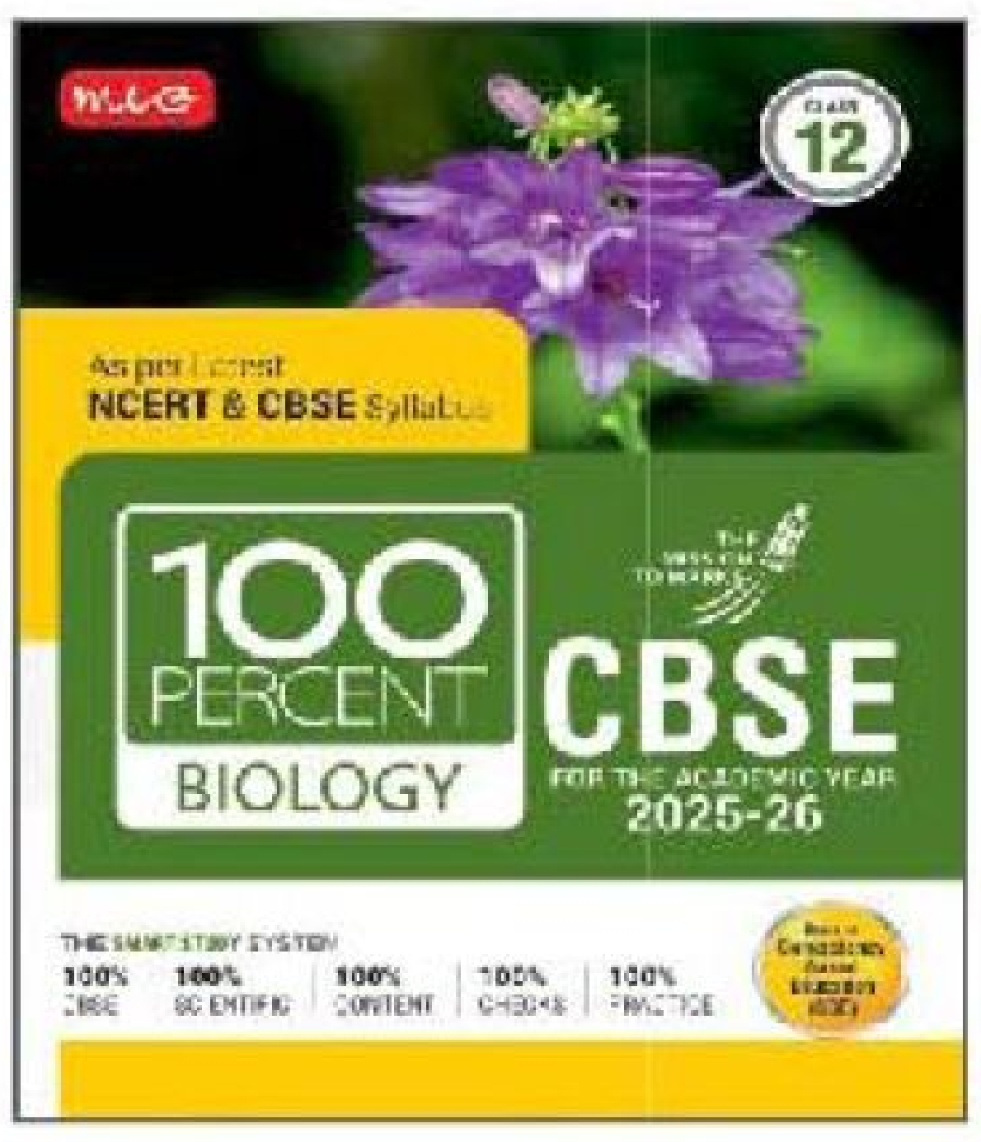

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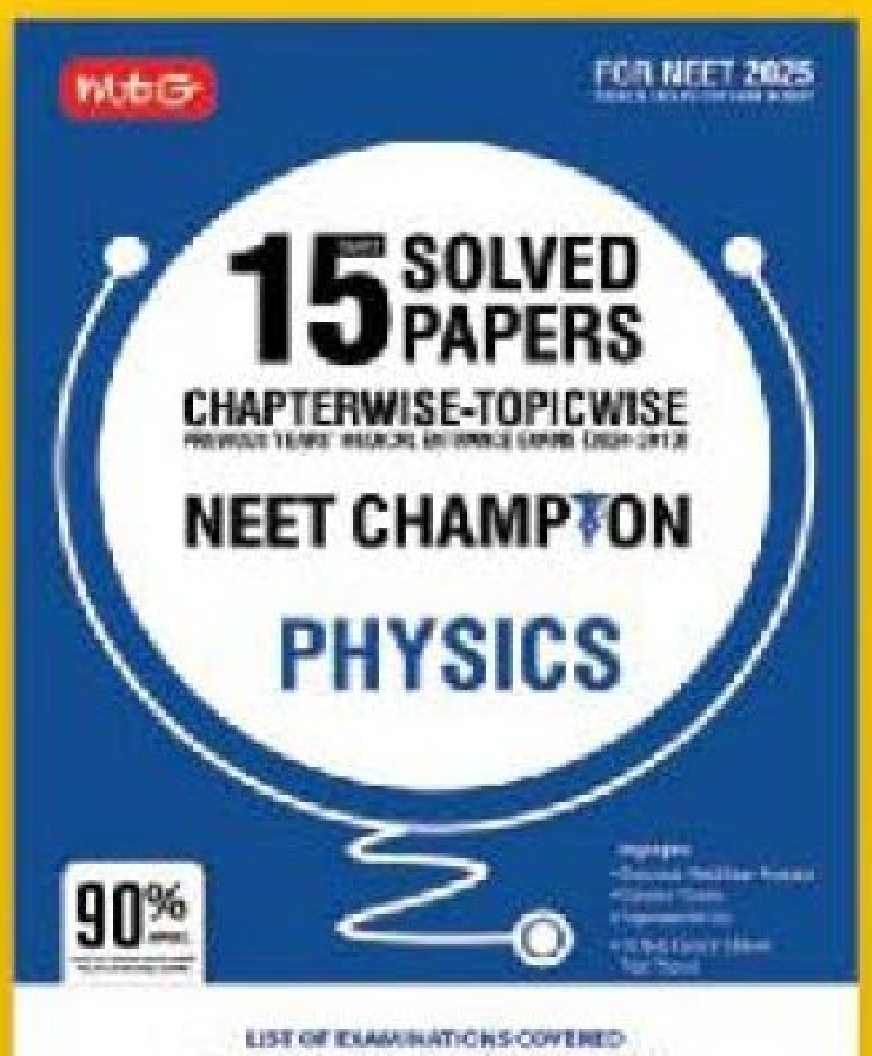
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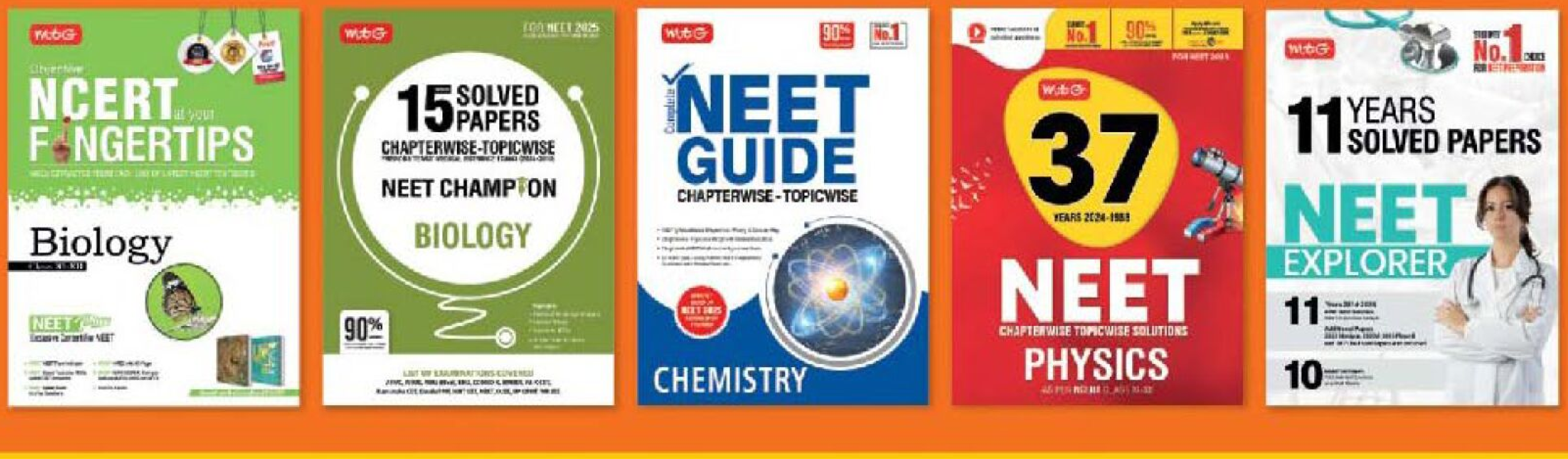
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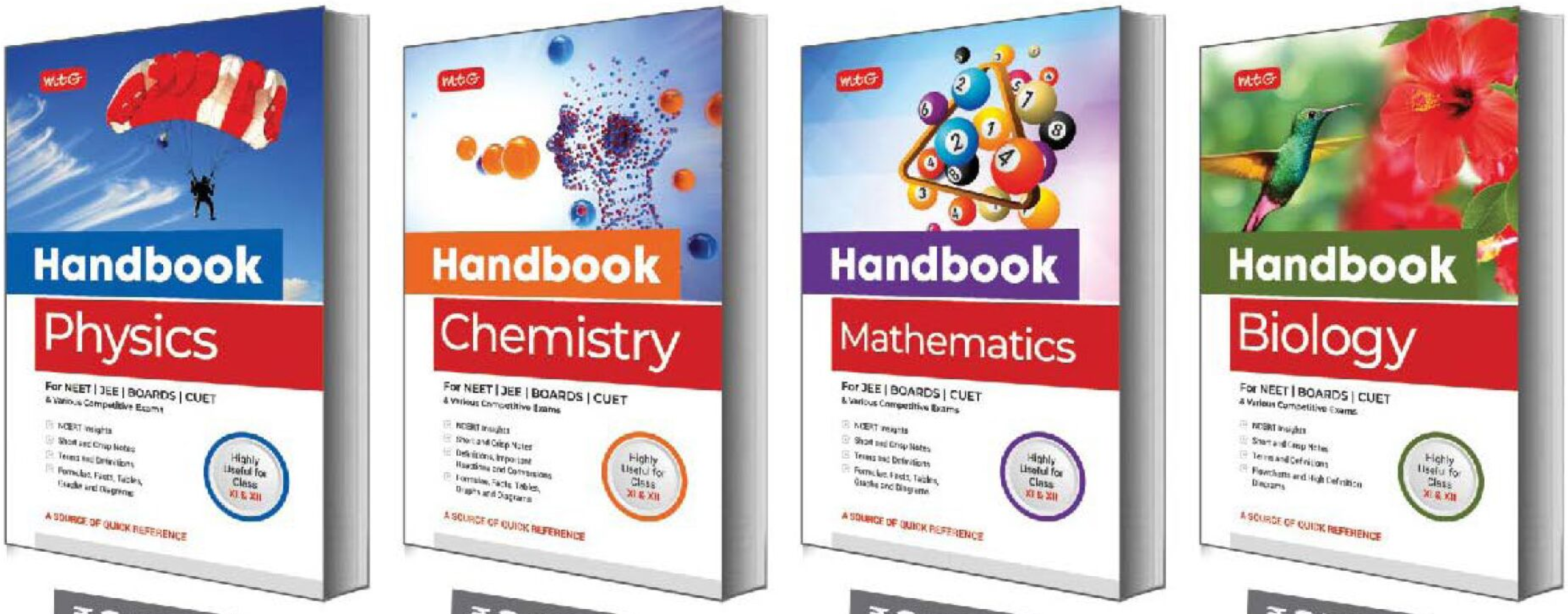

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